SARCOPTIFORMES (ACARI) OF SOUTH AUSTRALIAN SOILS. 4. PRIMITIVE ORIBATE MITES (CRYPTOSTIGMATA) WITH AN EXTENSIVE, UNFISSURED HYSTERONOTAL SHIELD AND APTYCHOID.

by

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ABSTRACT

LEE, D. C. 1985. Sarcoptiformes (Acari) of South Australian soils. 4. Primitive oribate mites (Cryptostigmata) with an extensive, unfissured hysteronotal shield and aptychoid. *Rec. S. Aust. Mus.* 19(4): 39-67.

A study of sarcoptiform mites from surface soil (greatest depth usually 4 cm) at nine florally diverse sites in South Australia is continued. Opisthosternal shields, supernumerary leg setae, gnathosternal fissures and cheliceral spatulae are considered separately. The Cryptostigmata is treated as including five suborders: Palacosomatida, Retrofissurida, Afissurida, Profissurida and Comalida. The Afissurida and primitive Comalida (i.e. Mixosomatina and Clinofissurae) are considered further in order to complete the lower oribate mites within this study. Five families are discussed although not represented by specimens in this study: the Eulohmanniidae to confirm its inclusion in the Mixosomatina; the Malaconothridae, Trhypochthonidae, Trhypochthoniellidae and a new family, Allonothridae, to delineate the two infraorders (Mixosomatina and Holosomatina) of the Comalida. Seven species of Afissurida, Mixosomatina and Clinofissurae were collected. Four species are new: *Platynothrus brevisetosus, Crotonia jethurmerae, Nanhermannia grandjeani, Phyllhermannia eusetosa.* Two subspecies are new: *Epilohmannia cylindrica media, Epilohmannia pallida australica. Papillacarus pseudoaciculatus* is newly recorded from Australia. A new synonym is *Vepracarus* under *Papillacarus.* New combinations are *egyptica* and *indica* (ex *Papillacarus*) with *Lohmannia,* and *koreanus, ogawai* and *ramirezae* (ex *Vepracarus*) with *Papillacarus.*

INTRODUCTION

This publication is a further part of an ongoing study (Lee 1981, 1982). Its intent is to complete the systematics of what are generally regarded as the primitive, lower or macropyline oribate mites. Because the higher classification has changed so much since this study began, the oribate mites considered here are not all closely allied. They appear to be similar because they are primitive but have an extensive unbroken hysteronotal shield (a derived character state convergent in two suborders) and are aptychoid (a character state ancestral to the derived ability to fold the proterosoma back onto the hysterosoma which has arisen in three suborders). The mites to be considered include the Lohmannioidea (Afissurida), the Mixosomatina (Comalida) and the Clinofissurae (Comalida-Holosomatina). The following families from the Mixosomatina have already been dealt with: Phthiracaridae and Euphthiracaridae under Euptyctima Lee 1981) as well as Gehypochthoniidae under Monofissurae (Lee 1982).

The numerous higher categories of oribate mites may be reduced, some becoming superfamilies, if there is compensation for the disproportionate tendency to "upgrade" the classification (Krantz 1978). However, these categories are retained here. I follow the recent discarding by O'Connor (1984) of the abnormal use of "cohort" in acarology. Instead, between infraorder and superfamily, the rank of *section* is used as for crustaceans (Kaestner 1970).

The mounting procedures used have sometimes resulted in squashed specimens. The possibility of such distortion, always represented in illustrations of gnathosterna where it facilitates description, should be considered.

All mites described in this study are deposited in the South Australian Museum, Adelaide.

MORPHOLOGY

Opisthosternal Shields and Setae

The opisthosternal shields may be defined by the setae they bear. Unfortunately, in the reduction from the primitive three pairs of setal files, it is difficult to assess which files are lost or merged. Therefore, the *genital* and *anal shields* are regarded as the movable shields covering the relevant orifices and bearing setal files *Jg* and *Zg* or *Ja* and *Za;* and if these shields bear only one setal file it is referred to as either *JZg* or *JZa* whether or not it appears likely that a specific file (e.g. *Ja* in some cases) is missing. The more lateral shields are the *aggenital* shield bearing setal file *Sg* and the *adanal shield* bearing setal file *Sa,* which may be merged to form the *opisthoventral shield.* In the Retrofissurida and Afissurida, the anal shield may be split into a *peranal shield* (bearing one or two setae *Ja*) and a *paranal shield*

(bearing two, three or four setae *Za*). In such cases, I have in the past (Lee 1982, Figs. 7 and 16) referred to these setal files with a different notation. In exceptional cases, as *Hoplophthiracarus shealsi* Lee, 1981 (see Fig. 25), the movable shield over the genital orifice bears three setal files indicating it is a merged genital and aggenital shield.

Chaetotaxy of Legs and Coxites

The leg tarsi of some species described below are hypertrichous. Lying proximally to the normal *complement setae*, the extra *supernumerary* setae are restricted to the four following positions: two dorsolateral—*da*, *dp* and two ventral—*av*, *pv*. The suffix "*x*" is added to the signature for each supernumerary setae, followed by a number indicating the position of the including whorl or rank, with "1" the most proximal.

The ventral coxite setae are in approximately single file and are numbered as such from the adaxial end without any attempt to homologize them with the files (anterior, median, posterior) from which they might be derived.

Gnathosternal Fissures and Cheliceral Spatula

Gnathosternal fissures are regarded as derived and may be functionally correlated with greater rigidity of the idiosoma requiring greater mobility of the mouthparts. The two types of fissure have been defined (Lee 1984). The species described below have *mento-coxal fissures*, whilst what was referred to as "diarthric" (Grandjean 1957) or a "quadrangulate mentum" (Lee 1982) occurs in more advanced taxa with *dicoxal fissures*. These two types of fissures split different parts of the gnathosternum (although the homologies of areas regarded as derived from either the palp coxite or mentum are not confidently held), whilst before the differences were regarded as due to a change in shape of the mentum. Apparently in rare cases both types of fissures occur on the same animal (see *Nothrus* species, Trägårdh 1931a: Fig. 6).

As previously (Lee 1984), the term *cheliceral spatula* is used for "Trägårdh's organ". The presence of a cheliceral spatula was regarded as a possible synapomorphy for the Holosomatina (Comalida) (Lee 1984). Norton (personal communication 1982) has since pointed out that the cheliceral spatula is present in a number of families of Mixosomatina (Comalida) and I discuss this further below under "Remarks" on that infraorder.

SYSTEMATICS

I accept the concept that the Cryptostigmata is a paraphyletic taxon as suggested by O'Connor (1984), with the Astigmata regarded as a sister-group to part of the Comalida (in the restricted sense used below). On the other hand, I do not in this instance follow the principle of Wiley (1981) that paraphyletic groups be rejected as unnatural, arbitrary, human constructs. I consider it useful to retain the Cryptostigmata as a grade, sharing similar primitive character states, and "left behind" by the considerable differentiation of the Astigmata.

The higher classification of the Cryptostigmata is modified so that it is regarded as including five suborders, sequenced to reflect their supposed level of advancement as follows: Palaeosomatida (see Bifemorata Lee, 1981), Retrofissurida (see Retrofissurae Lee 1982), Afissurida (see Afissurina Lee, 1984 and below), Profissurida (see Profissurae Lee, 1982 and Pediculochelidae) and Comalida (see Comalida, in part, Lee, 1984 and below). Changes from the classification presented at the 6th International Congress of Acarology in 1982 (Lee 1984) are that the Dismalida is disbanded and the included three distinct primitive lineages upranked to suborders, whilst the Profissurina is excluded from the Comalida and also upranked to a suborder. Four of these suborders may be regarded as clades, but the Comalida is not a complete clade since the Astigmata is excluded from it (although it may prove arguable that the entire Comalida is a sister-group to the Astigmata).

Upranking of the Profissurida is a response to the proposition (Norton, O'Connor and Johnston 1983) that the Pediculochelidae and Haplochthoniidae constitute the latest derivative lineage within the Protoplophoroidea (=Profissurida). Even if this phylogeny was well supported, I would maintain the Pediculochelidae as a separate superfamily on the basis of morphological divergence (widely separated coxites III-IV from I-II, terminal anus, pretarsal stalked pad), although I do tentatively accept that with the Protoplophoroidea it constitutes a monophyletic group. On the other hand the *late* derivative phylogeny of Pediculochelidae is not acceptable since there is no evidence suggesting an ancestor with hysteronotal intercalary sclerites and erectile setae, or that the absence of sclerotization and reduced setation (often a convergent similarity) are synapomorphies for a lineage composed of it and the Haplochthoniidae. I propose that the Pediculochelidae is regarded as an *early* derivative group as indicated by the primitively disjunct external malae. This suggests that the conjunct external malae of other Profissurida have arisen separately as an apomorphy convergent to a similar character state in the majority of the Comalida and therefore supports the upranking and exclusion of the Profissurida from the latter suborder.

Suborder AFISSURIDA

Diagnosis: Cryptostigmata. Hysteronotal shield lacks transverse fissures, but transverse furrows often present. Hysteronotal gland absent. Hysteronotal chaetotaxy

holotrichous or hypertrichous. Setal file *s* with two setae, both similar in size and shape to other proteronotal setae. Coxites merged, forming two podosternal shields (coxites I, II or III, IV). Cheliceral spatula absent. External malae disjunct. Gnathosternal fissures absent, but mentocoxal furrow sometimes present. Adoral setae in transverse row, at least adaxial two pairs large and flattened. Pretarsi with one claw. Tarsus I and genu I each with two solenidia. Tibia I solenidia flagelliform. Femora undivided. Nymphs with similar facies to adult.

Remarks: The Afissurida, also referred to as Afissurina (Lee 1984), includes only one superfamily, the Lohmannioidea: Grandjean, 1969. The Lohmannioidea was then included in the Mixonomata which approximates to the Mixosomatina (Comalida) considered below. Despite this, Grandjean (1950), in a thorough work on the Lohmannidae, has indicated that this family is very distinct from other oribate mites, but with distant affinities to certain "Enarthronota". I agree that it shares a number of primitive character states with the Retrofissurida (part of old "Enarthronota") such as disjunct external malae and a complete notal chaetotaxy, including two large, well-separated setae in file *s* and sixteen pairs of hysteronotal setae. On the basis of this, it is reasonable to regard the absence of a hysteronotal gland as primitive and not secondary as in some Mixosomatina (Comalida). Therefore, my inclusion of the Lohmannioidea in a separate, primitive suborder, with its extensive hysteronotal shield considered as convergent with that state amongst the Comalida, reflects the earlier (1950) conclusions of Grandjean rather than his later (Grandjean 1969) work.

Besides the Lohmanniidae, two other families have been recognised in the superfamily, each including only a single species. The Nothrolohmannidae Balogh, 1968 is recognisable by bifurcate seta *fl*, humeral processes bearing seta *Sl* and large triangular aggenital shield fused to posterior margin of coxite IV. The Xenolohmanniidae Balogh and Mahunka, 1969 has a "menton divided into two parts, not meeting medially". As illustrated, this structure appears as if it might represent a pair of broad flat processes extending forward from coxites I rather than an unusual gnathosternum.

Family LOHMANNIIDAE Berlese

Lohmannini Berlese, 1917b: 176
Lohmanniidae: Grandjean, 1950: 100
Lohmanniidae: Wallwork, 1962a: 457
Lohmanniidae: Corpuz-Raros, 1979: 315

Type-genus: *Lohmannia* Michael, 1898: 75

Diagnosis: Afissurida. Preanal shield present: either bar-shaped, T-shaped, or reduced to central knob. Aggenital shield sometimes present, but not fused to coxite IV or extending posteriorad to halfway along genital shield. No broad flat process extending forward from coxite I under gnathosternum. Hysteronotal seta *Sl* not on conspicuous humeral process. Proteronotal seta *fl* not bifurcate.

Morphology: Small to large (480-900) dull yellow or brown mites. Proteronotum long (0.4x length of hysteronotum) and broad (as wide as hysteronotum). Opisthosternum usually shorter than podosternum. Legs short (leg I longest, less than 0.4x idiosomal length). Palp femur and genu fused or partially fused. Genital shield bears 10 or more setae in two files (usually 6*Jg*, 4*Zg*), may be divided into subequal anterior and posterior parts. Setal files *Sg* and *Sa* absent. Anal shield may be divided into petanal and paranal parts. Solenidiotaxy I (2-1-2), II (1-1-1 or 2), III (1-1-0), IV (1-0-0).

Distribution: Widespread in tropics, where greatest generic diversity occurs. Particular species may themselves be widespread. Achieved "a greater degree of evolutionary radiation in Africa than in South America" with "a wide distribution in those parts of the world which belonged, formerly, to Gondwanaland" (Hammer and Wallwork 1979). In temperate regions, but generic diversity decreases away from tropics, *Lohmannia* being most widespread. In northern hemisphere, genera other than *Lohmannia* only found south of 45°N.

Some species known to burrow in roots or bark. Represented both in deserts and moist habitats such as coastal bogs. Ecological notes on species collected in Philippines (Corpuz-Raros 1979) indicate wide variety of niches which family can occupy in limited geographical area.

Remarks: The above diagnosis distinguishes the Lohmanniidae from the two very similar monospecific families also in the Afissurida and is, therefore, relatively trivial. A number of further character states are listed under "Morphology" which may apply to all three families.

Balogh (1972) included 20 genera in the Lohmanniidae. Amongst these, authors have regarded the following four genera as similar to *Papillacarus* (which is represented in this study): *Cryptacarus* Grandjean, 1950; *Dendracarus* Balogh, 1960; *Lepidacarus* Csiszar, 1961; *Vepracarus* Aoki, 1965b. On the basis of the disposition of the opisthosternal shields *Cryptacarus* and *Dendracarus* can be excluded. Whilst, as elaborated on below, *Lepidacarus* can also be distinguished, *Vepracarus* is regarded as synonymous with *Papillacarus*.

PAPILLACARUS Kunst

Papillacarus Kunst, 1959: 70. Type designation (original): "*Lohmannia murcioides* Berlese v. *aciculata* Berlese 1905".

Vepracarus Aoki, 1965b: 142. Type designation (original): "*Vepracarus ogawai* Aoki,spec.nov."—**n.syn.**

Type-species: *Papillacarus aciculatus* (Berlese, 1905: 24).

Diagnosis: Lohmanniidae. Genital shield divided by transverse fissure into two subequal shields. Anal shield divided by longitudinal fissure into peranal and paranal shields. Preanal shield reduced to central, bicornate knob. Rostral tectum blunt, anterior margin either smooth arc or sinuous with four slight tubercles or with three conspicuous tubercles (lateral tubercles where lamellae meet margin). Proteronotal plasmic seta (*z2*) with long cilia on only one side of slim or lanceolate main stem. Notal setae with cilia which may be inconspicuous or so long that setae bush-like. Posterior notal hypertrichy, never anterior to seta *J2*. Notal integument papillate. Ventral ridges on femora I and II. Analchaetotaxy: 2*Ja*, 4*Za*. Tarsi III and IV each with 10 setae. Tarsus II with two solenidia.

Distribution: Possibly almost limited to Old World. Virgin Islands (NTa); Annobon Island, Ghana (Ew); Crimea, Moscow, Ukrainia (Pe); Bulgaria, Greece, Italy, Spain, Tunisia (Pm); Korea, Japan (Pc); India (Oi); Thailand (Os); Java, Philippines (Om); South Australia (Aa). Known Oriental fauna shows greatest morphological diversity.

Found in grassland, feeding on grass roots, also under trees, where grass may or may not have been present.

Remarks: Three genera (*Lepidacarus, Papillacarus,* and *Vepracarus*) have the disposition of opisthosternal shields given in the above diagnosis. *Lepidacarus* can be distinguished from the other two genera by the preanal shield being an undivided central knob, as well as by the hysteronotal setae being leaf-like.

The only species of *Papillacarus* and *Vepracarus* that has been described in enough detail to include characters of the gnathosoma and legs is *P. angulatus*. Therefore, characters used to delineate these genera and their included species have to be limited to those of the idiosoma and in some cases to the notum. On the basis of such characters I have not been confident about distinguishing the two genera. Instead I have merged them and regarded *Papillacarus* as including the four following species-complexes based on the form and chaetotaxy of the hysteronotal setae. This is intended as a temporary measure until more characters are considered. Although the *aciculatus*-complex (includes type of *Papillacarus*) and *ogawai*-complex (includes type of *Vepracarus*) are easily delineated, this is undermined by the other two complexes. The fact that the *hirsutus*-complex includes species from both genera illustrates this confusion. The type complex is considered last since it includes the species found in South Australia. *P. egypticus* Elbadry and Nasr, 1977 and *P. indicus* Hafeez Kardar, 1972 are grouped in *Lohmannia*, **n.comb.**

hirsutus-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J4* or *J5*, area bearing 50-60 setae. Supernumerary setae short (length subequal to or less than distance between posterior setal bases), bush-like (because long cilia). Complement setae similar, indistinguishable. If any longer seta (uncertain if supernumerary or complement), then around posterior margin.

Remarks: Three species included in the complex. *P. hirsutus* (Aoki, 1961), ex *Cryptacarus* —Pc, Om, Ap. *P. chamartinesis* Perez-Iñigo, 1967—Pm. *P. koreanus* (Mahunka, 1973), ex *Vepracarus*, **n.comb.**—Pc.

ogawai-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J4*, area bearing 50-80 setae. Supernumerary setae short, bush-like. Complement setae at least twice as long, with inconspicuous cilia. Single rank of tubercles between setal ranks 5 and 6.

Remarks: Two species included in complex. *P. ogawai* (Aoki, 1965b), ex type of *Vepracarus*, **n.comb.**—Os. *P. ramirezae* (Corpuz-Raros, 1979), ex *Vepracarus*, **n.comb.**—Om.

ramosus-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J2*, area bearing 120-170 setae. Supernumerary setae short, bush-like. Complement setae *J4*, and those posterior to it, more than five times as long, with inconspicuous cilia.

Remarks: Two species included in complex. *P. ramosus* Balogh, 1961—Om. *P. cruzae* Corpuz-Raros, 1979—Om.

aciculatus-complex

Diagnosis: Papillacarus. Hypertrichy on hysteronotum posterior to seta *J4*, area bearing 20-45 setae. Supernumerary setae short but similar in form to complement setae, so both with inconspicuous cilia, not bush-like.

Remarks: Six species included in complex. *P. aciculatus* Berlese, 1905—Pe, Pm. *P. angulatus* Wallwork, 1962a—Ew. *P. undirostratus* Aoki, 1965b-Os. *P. ondriasi* Mahunka, 1974—Pm. *P. pseudoaciculatus* Mahunka, 1980a—Pm, Aa. *P. vitis* Elbadry and Nasr, 1977—Pm.

Papillacarus pseudoaciculatus Mahunka

(Figs 1, 2)

Papillacarus pseudoaciculatus Mahunka, 1980a: 126

Tritonymph

Dull, ochre-coloured with yellowish brown cheliceral extremities, external malae and legs. Cuticle of shields mainly granulate except in transverse hysteronotal furrows and in small, usually marginal patches. Similar

but less extensive areas papillate, protuberances being aciculate (as few on gnathosternum, illustrated Fig. 1). Cuticle of prehysteronotal fissure strongly striated suggesting propodosoma can flex downward. Idiosomal length 510 (1); appendage lengths—*ch* 42.5, *pa* 45, *I* 180, *II* 160, *III* 135, *IV* 175; femur breadths—*pa* 12.5, *I* 50, *II* 45, *III* 37.5, *IV* 42.5.

Cheliceral seta *ch*1 much shorter than *ch*2. Mentocoxal furrow present, clearly not fissure. Rostral tectum hyaline, indistinct, possibly smooth arc. Dorsolateral longitudinal fissure from anterior margin of hysteronotal shield back to level of preanal shield. This delineates dorsal margin of pleural shield which bears no setae but slit-like pore (*hf*1) at anterodorsal corner. Few supernumerary hysteronotal setae (?six) so area behind *J*4 bearing about 18 setae. Cilia on hysteronotal setae longer than depicted on type specimen, more like *P. ondriasi* (Mahunka 1974: 575, Fig. 8), but supernumerary setae relatively longer. Seta *J*6 conspicously longer than surrounding setae. Six transverse hysteronotal furrows, only anterior furrow just behind seta *J*1 complete, posterior furrow level with seta *J*4 reduced to two indistinct pits. Indistinct structures may represent two pairs of genital papillae. Five pairs of setae on anterior genital shield and four pairs on posterior genital shield (7*Jg*, 2*Zg*), possibly *Zg*3 missing from adult complement.

Material examined: One tritonymph (N19831), bases of grasses and plantains, Glenthorne, 12.6.1974, D. C. Lee.

Distribution: Tunisia (Pm); South Australia (Aa). South Australia: Glenthorne, cultivated pasture, 1 tritonymph (– /8).

Remarks: The referral of this single specimen to be a tritonymph of *P. pseudoaciculatus* is not done with confidence. The identification is based mainly on the low number of supernumerary hysteronotal setae, but this may be related to it being an immature stage. The extensive somal coverage with aciculate protuberances in dense patches excludes some other species. Since the species are so similar in the *aciculatus*-complex, the above tritonymph could represent a new species.

Suborder COMALIDA

Diagnosis: Cryptostigmata. Hysteronotal shield usually lacks transverse fissures (exceptions: *TB*2 present in most Eumixosomatae, ?*TB*1 present in some *Platynothrus* and *Crotonia* species). Hysteronotal gland usually present (exceptions: absent in Eulohmanniidae, Nanhermanniidae, Phthiracaridae, Synichotritiinae). Hysteronotal chaetotaxy usually hypotrichous, with at least seta *J*4 and/or *Z*4 vestigial or absent (holotrichous exceptions: some Eumixosomatae, Eulohmanniidae, some Clinofissurae). Setal file *s* with one or two setae, if two, then at least one 0.5x length or less, of proteronotal seta *j*2. Coxites rarely discrete, varying degrees of fusion may merge into single podosternal shield. Cheliceral spatula present or absent. External malae conjunct or coarctate. Gnathosternal fissures absent or mentocoxal and/or dicoxal fissures present. Adoral setae positioned so that at least *ao*1 anterior to *ao*2. Pretarsus with one, three or rarely two claws. Genu I with one (true for all species with two solenidia on tarsus I), two or three solenidia. Tibia I solenidia baculiform, piliform or flagelliform. Femora undivided. Nymphs with similar or dissimilar facies to adult.

Remarks: The Comalida (Lee 1984) is diminished to exclude the Profissurina as commented on under "Systematics" above. This leaves it restricted to two infraorders: Mixosomatina and Holosomatina. The Mixosomatina and amongst the Holosomatina, the Clinofissurae, are dealt with below. Thus, within my study of South Australian oribate mites, three sections (Pherenotae, Gymnonotae and Poronotae) of Holosomatina will not have been considered.

The synapomorphy of the Comalida is still regarded as the conjunct or coarctate position of the external malae, but it is now treated as convergent with that character state in the upgraded Profissurina. A general trend can be recognised in the adults to derived character states such as a strongly sclerotized integument, fused somal shields, fissured gnathosternum, conspicuous somal ridges (lamellae, pteromorphs, tecta), fewer hairs (setae, solenidia), heteromorphic leg segments and a more complex respiratory system (pores, tracheae). Since a similar trend does not occur in the immature stages, they tend to be dissimilar to the adults in all but the more primitive taxa.

Relationships within the Comalida, which includes the great majority of extant oribate species, are not well understood. I have assigned the advanced taxa to the Holosomatina, which is regarded as monophyletic. The remaining distantly related taxa are provisionally referred to the Mixosomatina, which is regarded as a primitive grade.

The Comalida is regarded as paraphyletic because the Astigmata is not included (see "Systematics" above). This is preferred since it provokes the search amongst the Comalida for the sister-group to the Astigmata, a more acceptable phylogeny, since the primitive nature of *Parhypochthonius* suggests that it is ancestral within a lineage including both of these taxa. If this search is not fruitful, however, it may prove desirable to regard the entire Comalida as a sister-group to the Astigmata and so monophyletic.

Infraorder MIXOSOMATINA

Diagnosis: Comalida. Transverse midpodosternal fissure between coxites II and III. Often two solenidia on genu I, if only one solenidium then either transverse hysteronotal fissure *TB*2 present (some Gehypochthoniidae) or opisthosternal setation reduced (at least setae *Sg* absent and usually only one seta *JZa*—

Neomixosomatae). Adanal shields never merge behind anal shields. Cheliceral spatula present or absent.

Remarks: The Mixosomatina includes three sections (Eumixosomatae, Mesomixosomatae and Neomixosomatae) much as before (Lee 1984) except that the latter section has been extended to include the Trhypochthoniidae and Trhypochthoniellidae. Within my study of South Australian oribate mites, members of the Eumixosomatae have already been considered under "Monofissurae" within the "Arthronotina" (Lee 1982), but it should be noted that the recently included (Lee 1984) North American Nehypochthoniidae Norton and Metz, 1980 lacks a transverse hysteronotal fissure, which requires a change in the diagnosis. The other two sections are considered below, although no members of the Neomixosomatae were found in this study.

The Mixosomatina has no synapomorphy, but is recognisable by the primitive character state of a podosternal fissure which allows the propodosoma to move in relation to the metapodosoma. In some taxa with a strongly sclerotized cuticle, this flexibility is accentuated by a number of derived states such as in ptychoidy, when the legs are pulled up into the soma and the proteronotum flexed downward to close on a forward facing section of the genital shield, or when the propodosoma can partially telescope into the metapodosoma.

Relationships within the Mixosomatina are uncer tain, partly because some primitive character states may or may not be secondarily reverted to in advanced taxa. The weakly sclerotized cuticle of the Eumixosomatae is primitive in the Parhypochthioidea and the Nehypochthoniidae but in the Neomixosomatae it may be either reverted to or there may not have been any strongly sclerotized ancestors. Furthermore, whilst I (Lee 1984) considered that the absence of cheliceral spatulae was primitive but diagnostic of the Mixosomatina, Norton (personal communication, 1982) has pointed out that cheliceral spatulae do occur in some Mixosomatina. He has observed cheliceral spatulae in *Collohmannia gigantea* and a new North American species of Collohmanniidae. Also, their presence in Perlohmanniidae is suggested in an illustration by Grandjean (1958: Fig. 5A), and I have now included the Trhypochthoniidae and Trhypochthoniellidae in Mixosomatina, both of which have cheliceral spatulae. Trägårdh (1931b) recorded cheliceral spatulae on *Phthiracarus maculatus*, but this was refuted by Grandjean (1959) who considered the structure to be an oncophysis. Cheliceral spatulae are considered to be absent in all Eumixosomatae, some Mesomixosomatae (Epilohmanniidae, Eulohmanniidae, Phthiracaridae, Eupthiracaridae) and some Neomixosomatae (Malaconothridae). Therefore, although primitively absent, some taxa without cheliceral spatulae may have ancestors that possessed them.

The three sections within the Mixosomatina are grades. The Mesomixosomatae include a number of specialized lineages, whilst the Eumixosomatae are apparently primitive (certainly so in the case of *Parhypochthonius*, but possibly *Elliptochthonius* reflects specialization to living in the deeper soil layers) and the Neomixosomatae include advanced lineages which may be ancestral to the Holosomatina. Regarding the relationships of the Astigmata, I hold to a conservative belief that weak sclerotization in the Astigmata is an ancestral character state and not a reflection of neoteny as proposed by O'Connor (1984). Therefore, a sister-group to the Astigmata would have a weakly sclerotized adult, as well as lacking a rostral tectum and cheliceral spatulae. Possibly, reduction in the fourth hysteronotal setal rank would be the synapomorphy, placing this sister-group within the Eumixosomatae. However, a stringent analysis will be a necessary prelude to developing a durable model for the areas only speculated on here.

Section MESOMIXOSOMATAE

Diagnosis: Mixosomatina. Hysteronotal shield without transverse fissures. Rostral tectum present. Gnathosternum with Λ-shaped mentocoxal fissure. Adoral setae in three conspicuous pairs. Opisthosternal setal files *Sg* with at least one seta, *JZa* with at least two setae. Proteronotal setal file *s* with one or two setae. Genu I with two or rarely three solenidia.

Remarks: The Mesomixosomatae is a diverse group of small families which, although having a strongly sclerotized adult cuticle, have maintained flexibility by developing various specialized ways of moving the propodosoma in relation to the hysterosoma. I have not attempted any superfamily groupings. Even grouping the six families into aptychoid (Collohmanniidae Grandjean, 1969; Epilohmanniidae Oudemans, 1923; Eulohmanniidae Grandjean, 1931; Perlohmanniidae Grandjean, 1954a) and ptychoid (Euphthiracaridae Jacot, 1930; Phthiracaridae Perty, 1841) taxa is questionable. The ptychoid families have already been considered in this study (Lee 1981) as the Euptyctima. The Epilohmanniidae is represented in collections for this study and is considered below. Although not represented, the Eulohmanniidae is also considered in order to confirm its grouping in this section despite possessing some primitive character states suggesting it might even be grouped with the Afissurida.

Family EPILOHMANNIIDAE Oudemans

Lesseriidae Oudemans, 1917: 78.
Epilohmanniidae Oudemans, 1923: 79
Epilohmanniidae: Grandjean, 1954a: 430.
Epilohmanniidae: Grandjean, 1969: 144.
Epilohmanniidae: Norton, Metz & Sharma, 1978: 145.
Type-genus: *Epilohmannia* Berlese, 1917b.

Diagnosis: Mesomixosomatae. Minute to medium-sized (320-800) yellow to brown mites. Extensive non-sclerotized cuticle at transverse midpodosternal fissure between coxites II and III allows propodosoma to partially telescope in and out of metapodosoma. Otherwise, extensive sclerotized somal shields, with coxites fused to each other, aggenital shield and usually mentum (exception *Epilohmannoides jacoti*). Posterior end of aggenital and anterior end of adanal shields truncated or fused together so that ventrolateral longitudinal fissure straight. Adanal shield merges medially as broad band in front of anal shields. Cheliceral spatula absent. Palpal segments fused so that only two separate. Adoral seta *ao*1 bifurcate. Hysteronotal gland present, pore opens into depression also containing alveolus of relic seta *Z*4, whilst seta *J*4 similarly absent. Opisthosternal setal file *Sg* includes 3-7 pairs. Opisthosternal pores *Zaf* and *Saf* present. On tarsus I seta *pd*3 reduced to scale closely associated with distal face of solenidium *so*4. On tibia I solenidium flagelliform, longer than segment.

Distribution: Possibly cosmopolitan. Wallwork (1962b) states that Epilohmanniidae "appears to be widely distributed through the warmer regions of the world". Records from southern Canada (Nn) and Moscow (Pc) could be most northerly, with records from South Australia (Aa) being most southerly, suggesting predominantly pantropical distribution becoming sparse in temperate regions up to 57 °N and 35 °S. Outside Antarctica and Subantarctic, South Ethiopian and New Zealand-Australian may be only minor regions in which family not represented.

Microhabitats range widely from grass roots, vineyards and forests, but possibly do not include arid or semi-arid environments.

Remarks: The Epilohmanniidae includes the typegenus and *Epilohmannoides*. Norton, Metz and Sharma (1978) in describing two species of *Epilohmannoides* also give a diagnosis for the family on which the above diagnosis is based.

EPILOHMANNIA Berlese

Epilohmannia Berlese, 1917b: 176. Type designation (original): "*Lohmannia cylindrica* Berl.".

Lesseria Oudemans, 1917: 78. Type designation (original): by monotypy ("*Lesseria szanisloi* Oudms. 1915", synonym of *Epilohmannia cylindrica* by van der Hammen 1959: 54).

Type-species: *Epilohmannia cylindrica* (Berlese, 1905: 23).

Diagnosis: Epilohmanniidae. Opisthoventral shield divided into two parts by transverse fissure just posterior to genital shield. Genital and anal shields oblong rather than suboval; posterior margin of genital shield and anterior margin of anal shield being broad-shouldered. Trochanter III and IV with distal axis at right angles to proximal axis. Acetabulum IV on same longitudinal line as III, both divided by spurs into double opening.

Distribution: As for Epilohmanniidae.

Remarks: The more complex form of trochanter III and IV and their acebatula with double openings, suggest that these legs can lock into either of two basic positions and, further, indicates that *Epilohmannia* may be derived from the much less diverse (four compared with 26 species) *Epilohmannoides* with simpler posterior trochanters and acetabula.

Balogh and Mahunka (1979) have distinguished within *Epilohmannia* a subgenus, *Sinolohmannia*, by the presence of a spine-like seta *d* associated with the solenidium on tibia IV. The *cylindrica*-complex of Schuster (1960) can be regarded as equivalent to the nominate subgenus. A more conspicuous character state, the position of the acetabulum on coxite IV, has not been referred to in grouping species. Both the species considered below have the acetabulum IV on the posterior margin of coxite IV, but it may be near the anterior margin or in between. However, the included species are similar and, unfortunately, the specimens collected in this study belong to species with a number of even more similar subspecies. Since I am not confident about grouping them in any of the subspecies, new subspecies have had to be established. Because of the similarity of the established subspecies, references to them are included under the new subspecies.

The illustrations of one species in this paper are intended to show character states delineating the family and genus rather than the subspecies.

Epilohmannia cylindrica (Berlese) *media* n.ssp.
(Figs 3-5)

Lohmannia cylindrica Berlese, 1905: 23.

Lesseria szanisloi Oudemans, 1917: 78.

Epilohmannia szanisloi Schuster, 1960: 202 (including *minima*, p. 205).

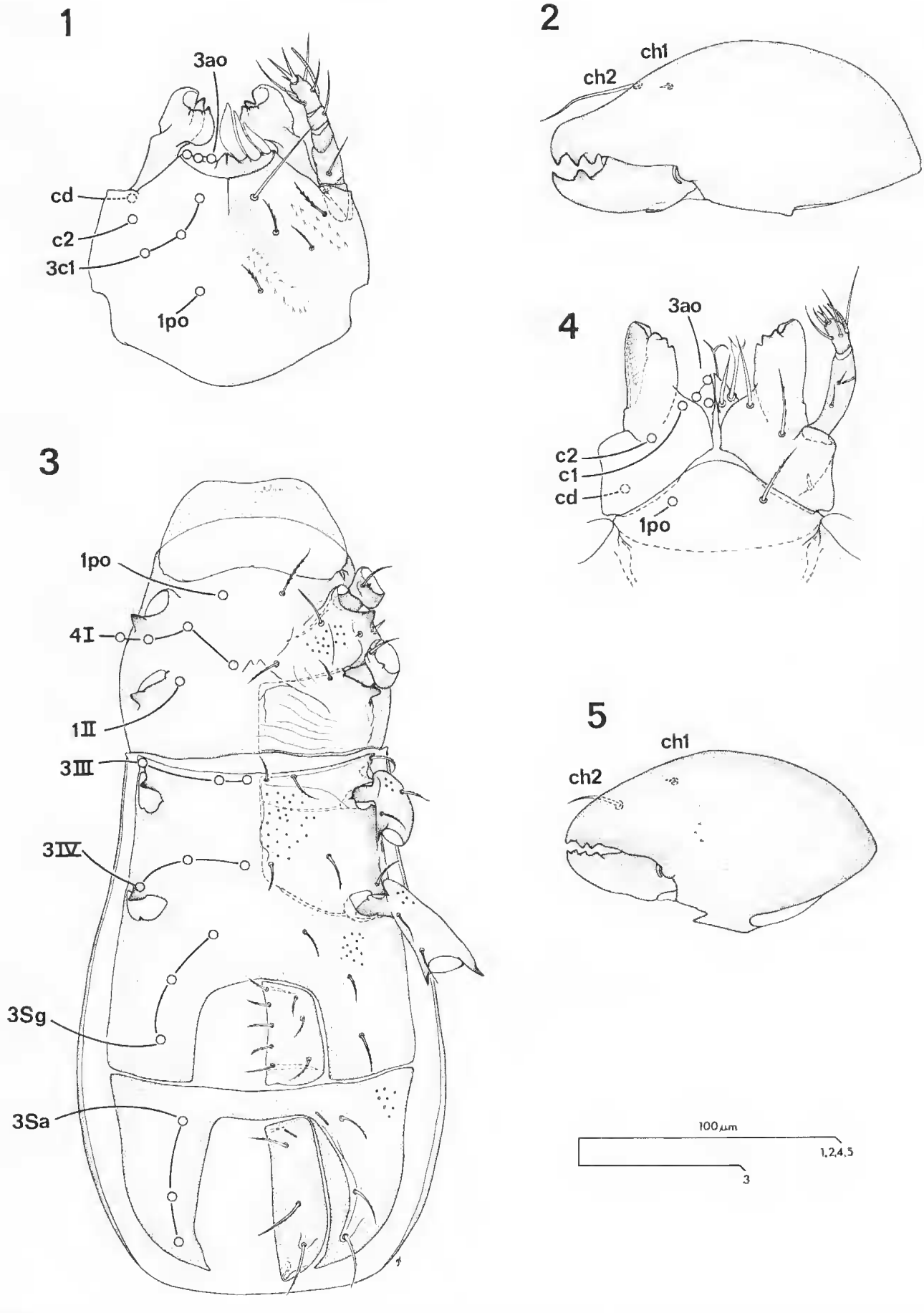
Epilohmannia cylindrica Aoki, 1965c: 309.

Epilohmannia cylindrica Bayoumi and Mahunka, 1976: 6.

Female

Dull (slight greasy shine) chestnut brown, slightly darker cheliceral extremities and external malae, extensive pale straw-coloured cuticle between proterosoma and hysterosoma when extended. Most of hysterosternum with sparse puncta, limited in other parts of venter to areas illustrated (Fig. 3). Idiosomal length (abutting margins to midpodosomal fissure, possible extension 50, retraction 30) 465 (10, 415-525); appendage lengths (for 475)—*ch* 45, *pa* 50, *I* 195, *II* 175, *III* 195, *IV* 275; femur breadths—*pa* 7.5, *I* 20, *II* 20, *III* 15, *IV* 20; broadest segment breadth—*I*, genu 32.5, *II* genu 30, *III* trochanter 25, *IV* trochanter 37.5.

Appendage setae: *ch* (2), *pa* (3-8), *I* (1-4-5-5-17), *II* (1-4-5-5-12), *III* (2-3-4-4-10), *IV* (2-3-4-4-9). Solenidia: *I* (2-1-3), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Solenidia of



FIGS. 1-5. *Papillacarus* and *Epilohmannia:* 1-2, *Papillacarus pseudoaciculatus* Mahunka, tritonymph; 1, gnathosternum; 2, right chelicera, anterior surface; 3-5, *Epilohmannia cylindrica* (Berlese) *media* n.ssp., female; 3, idiosternum; 4, gnathosternum; 5, right chelicera, anterior surface.

genua and tibiae flagelliform with minute, closely associated seta *d* (possibly partially coupled—see *Epilohmannoides terrae*: Norton, Metz and Sharma, 1978), on legs III and IV seta *d* only recognised when separated from solendium by preparation of specimen. Solenidium *so*4 (*so*3 regarded as absent) on tarsus I also flagelliform with minute seta *pd*3 closely associated with distal face. Other solenidia on tarsi I and II ceratiform.

Chelicera without spatula, small process (Fig. 5) posterior to movable digit probably chitinous plate representing reduced trochanter. Adoral setae *ao*1 and *ao*2 bifurcate. Genital shield setae: 5*Jg*, 3*Zg*.

Tarsus IV with length 5.5x breadth, and setae *v*1 and *v*2 (see Schuster 1960: Fig. 5 a- *k*1 and *k*2) spine-like, but less robust than for *E. cylindrica minima* (see Schuster 1960: Fig. 5b). Seta *v*2 nearer to *v*1 than to *v*3.

No eggs observed, specimens assumed female since, amongst eight pairs of setae on positor, three *pg* pairs well apart from rest, two *dg* pairs longer. One to three boli in each specimen, light to dark brown heterogeneously granular contents without recognisable cellular structures.

Material examined: South Australia (Aa). Holotype female (N19832), nine paratype females (N19833-N19831), bases of grasses and plantains, Glenthorne, 12.6.1974, D. C. Lee.

Distribution: E. cylindrica (subspecies *media* only known from South Australia). Tennessee (Na); Tchad (Ee); Austria, Egypt, Hungary, Italy, Moscow, Sicily, Spain (Pe); Turkestan (Ps); Philippines (Om); South Australia (Aa); Hawaii (Ap). South Australia: Glenthorne, cultivated pasture, 10 (2/8).

Remarks: E. cylindrica media lies between *E. c. cylindrica* and *E. c. minima* in a gradation of character states. As indicated by Schuster (1960), *E. c. cylindrica* is 435-573 long, has tarsus IV length 5.6x breadth, with setae *v*1 and *v*2 setose, whilst *E. c. minima* is 370-440 long, has tarsus IV length 3.6x breadth with setae *v*1 and *v*2 robust and spine-like (more so than *E. c. media*).

Epilohmannia pallida Wallwork *australica* n.ssp.
(Fig. none)

Epilohmannia pallida Wallwork, 1962b: 689.
Epilohmannia pallida pacifica Aoki, 1965c: 312.
Epilohmannia pallida aegyptica Bayoumi & Mahunka, 1976: 8.
Epilohmannia pallida indica Bhattacharya & Banerjee, 1980: 19.
Epilohmannia pallida americana Balogh & Mahunka, 1981: 59.

Female

Dull brown, paler but similar to *E. cylindrica*. Idiosomal length (abutting margins to midpodosomal fissure, possible extension 42.5, retraction 25) 400 (2 ex Piccaninnie Ponds, 420-425; 3 ex Chambers Gully, 350-405); appendage lengths (for 405)—*ch* 40, *pa* 45, *I* 155, *II* 130, *III* 140, *IV* 190; femur breadths—*pa* 10, *I* 22.5, *II* 20, *III* 15, *IV* 15; broadest segment breadths—*I* genu 27.5, *II* genu 25, *III* trochanter 17.5, *IV* trochanter 25.

Appendage setae: *ch* 2, *pa* (3-8), *I* (1-3-4-5-15), *II* (1-4-4-4-12), *III* (2 or 3-3-3-3 or 4-10), *IV* (2-3-3-4-9). Compared with *E. c. media* seta *va* absent on femur I, genua I and III, whilst seta *vp* absent on genua III and IV. On genu I seta *v* small. Solenidia similar in number, shape and size to *E. c. media*, except on genua III, IV and tibiae III, IV, solenidia relatively longer.

Chelicera without spatula. Adoral setae *ao*1 and *ao*2 bifurcate. Genital shield setae: 5*Jg*, 3*Zg*.

Characters previously used to delineate subspecies as follows. Hysteronotal setae sparsely ciliate and tapering, seta *Z*1 posterior to *J*1, distance *J*1-*Z*1 subequal to *J*1-*J*1. Anterior apodeme to coxite I curves back to single apodeme separating coxites I and II without connecting ridge to partner, coxite seta *III* 2 subequal in length to *III* 3, lateral margin of coxite IV straight. Opisthosternal seta *Sg*2 level with *Jg*1, setal file *Zg* separate from file *Jg* by distance subequal to length of *Zg*1, slit pore *Saf* inclined at angle less than 25° from transverse axis. Distal end of trochanter III without dorsal spur, on tarsus IV seta *v*2 nearer *v*1 than *v*3.

No eggs observed, specimens assumed female since amongst eight pairs of setae on positor, three *pg* pairs well apart from rest, two *dg* pairs longer. One or two boli in each specimen, light to dark brown heterogeneously granular contents without recognisable cellular structures.

Material examined: South Australia (Aa). Holotype female (N198312) and two paratype females (N198313, N198314), grass and moss or litter under *Eucalyptus viminalis*, Chambers Gully, 12.6.1974, D. C. Lee. Two paratype females (N198315, N198316), litter and sparse grass under *Acacia sophorae*, Piccaninnie Ponds, 20.8.1975, D. C. Lee.

Distribution: E. pallida (subspecies *australica* only known from South Australia). Texas, Minnesota, North Dakota, South Dakota (Na); Paraguay (NTb); Ghana (Ew); Egypt (Pe); West Bengal (Oi); Hong Kong (Os); South Australia (Aa); Hawaii (Ap). South Australia: Chambers Gully, savannah woodland, 3 (2/8); Piccaninnie Ponds, coastal closed-scrubland 2 (2/8).

Remarks: E. pallida is not very different from *E. cylindrica* (especially if the comparison is made to *E. c. minima*) except that seta *d*2 on tarsus IV is conspicuously spine-like.

The other five subspecies of *E. pallida* are very similar. *E. p. australica* can be distinguished from these by the character states listed above. On the basis of these it is most similar to *E. p. indica* and *E. p. pacifica*, but differs in two states regarded as important: the shape of the anterior coxite apodemes and the position of seta *v*2 on tarsus IV. One character, the chaetotaxy of the genital

shield sometimes used to distinguish subspecies, has not been listed as such because of its intraspecific variation (see McDaniel and Bolen 1983).

Family EULOHMANNIIDAE Grandjean

Eulohmanniidae Grandjean, 1931: 144
Eulohmanniidae: Grandjean, 1954a: 429

Type-genus: *Eulohmannia* Berlese, 1910.

Diagnosis: Mesomixosomatae. Medium-sized (650-700) straw-coloured mites. Extensive nonsclerotized cuticle at transverse midpodosternal fissure between coxites II and III allows propodosoma to partially telescope in and out of metapodosoma. Otherwise, extensive sclerotized somal shields, with coxites fused to each other and aggenital shield. Posterior end of aggenital and anterior end of adanal shields taper so that ventrolateral longitudinal fissure V-shaped. Adanal shield not merged medially in front of anal shields. Cheliceral spatula absent. Palpal segments fused so four separate. Adoral seta *ao*1 not bifurcate. Hysteronotal gland absent. Hysteronotal chaetotaxy holotrichous, fourth setal rank not reduced. Opisthosternal setal file *Sg* hypertrichous and dispersed, 15 or more setae. Opisthosternal pore *Saf* present, *Zaf* absent. On tarsus I, seta *pd*3 setose and well separated from solenidium *so*4. On tibia I, solenidium piliform, shorter than segment.

Distribution: Holarctic.

Remarks: The Eulohmanniidae includes one species, *Eulohmannia ribagai* Berlese, which has been described a number of times, perhaps the most accurate and comprehensive illustration being that by Lebrun and Wauthy (1981: Fig. 2). But there appears to be no detailed description of the gnathosternum. Since the species has a number of primitive character states such as a holotrichous hysteronotal chaetotaxy and no hysteronotal gland, it was necessary to check the gnathosternum to evaluate whether or not the species was correctly grouped in the Comalida. This was made possible by a gift of two specimens from Dr. Georges Wauthy.

Eulohmannia ribagai Berlese
(Fig. none)

Lohmannia (Eulohmannia) ribagai Berlese, 1910: 223.

Adult

Idiosomal length 655 and 695. Cheliceral spatula absent. Mentocoxal fissure present, Λ-shaped. External malae conjunct, distally with two lateral robust refractile teeth and median hyaline flap. Gnathosternal chaetotaxy reduced: 3*ao*, 2*cv*, 1*po*. Gnathosternum elongate much as *Perlohmannia dissimilis* (see Woolley 1969: Fig. 10). Tarsus I with 23 setae and three solenidia. The shape and positioning of plasmic seta *d*l and three solenidia much as *Perlohmannia dissimilis* (see Grandjean 1958: Fig. 6C); seta *d*l short with distal knob, solenidia well separated from setae.

Material examined: Two adults (N1983103, N1983104), litter and humus, Lauzella Wood, Belgium, 4.1980, G. Wauthy.

Remarks: Having seen details of the gnathosternum, there is no doubt that *Eulohmannia* is well placed in the Comalida, and therefore that some apparently primitive character states, such as the absence of hysteronotal glands and holotrichous hysteronotal chaetotaxy, are derived reversals. Although *Eulohmannia* in general form and extent of sclerotization resembles *Epilohmannia*, it exhibits similarities to *Perlohmannia* of the gnathosternum and tarsus I which suggests they may be regarded as sister-groups.

Section NEOMIXOSOMATAE

Diagnosis: Mixosomatina. Hysteronotal shield without transverse fissures. Rostral tectum present. Gnathosternum either without fissure or Λ-shaped or what may be transverse linear mentocoxal fissure present. Adoral setae present or absent. Opisthosternal setal file *Sg* absent, *JZa* usually with only one seta (exception: *Mucronothrus*—2*JZa*). Proteronotal setal file *s* absent, plasmic seta *z*2 may be reduced and setiform. On genu I, one solendium.

Remarks: The Neomixosomatae was established (Lee, 1984) to include the Malaconothridae which has a conspicuous fissure between coxites II-III and lacks a cheliceral spatula, but is in some ways similar to the Nothroidea, the most primitive of the Holosomatina. As indicated in the above "Remarks" under Mixosomatina, it has now been established that cheliceral spatulae occur on some of its members. This means that the Trhypochthoniidae: Balogh, 1972 is not excluded from the Mixosomatina by possessing cheliceral spatulae and so the relevant literature has been examined, even though no representatives were collected in this study. The result is that a number of changes are made to the classification, most genera of Trhypochthoniidae including the type-genus being included in the Mixosomatina. On the other hand, two genera have been grouped in a new family retained within the Holosomatina. The three families (Malaconothridae, Trhypochthoniidae and Trhypochthoniellidae) now in the Neomixosomatae are briefly commented on below.

I wish to emphasize the provisional nature of this classification and that I have ignored some character states considered in the more comprehensive studies of relevant families by Knulle (1957) and van der Hammen (listed by van der Hammen, 1959) because they are only

known for a few species. Since those studies, four genera have been added to the eight genera (included by Balogh, 1972 within the Trhypochthoniidae and Malaconothridae) and, both before and after the studies, the majority of species descriptions have not been extensive enough, in some cases with debatable generic combinations. Therefore, a thorough reinvestigation of established taxa is needed before reliable diagnoses can be given to them, and their considerable relevance to the classification of Comalida understood.

Family MALACONOTHRIDAE Berlese, 1917b

Diagnosis: Neomixosomatae. Cheliceral spatula absent. Adoral setae reduced to two pairs or all absent. Gnathosternal fissure absent or, if part of mentocoxal fissure present, lateral parts never meet at mid-point. Proteronotum without setal file *s* and seta *z*2 setiform and less than 0.5× length *j*2. Hysteronotal seta *Z*2 nearer *Z*3 than *J*2. Coxite II posterolateral corner extended as carina with backward facing socket. Opisthosternal setal file Sa with three setae. On tarsus I, three solenidia clustered between level of setae *pd*2-*pd*3. On tibia I, one solenidium.

Remarks: The posterolateral corner of coxite II may act as a socket into which trochanter III fits, possibly functioning as a pivot when the propodosoma flexes to one side. Such a movement could be limited in some species by a large tectum, projecting laterally from just posterodorsally to acetabulum II, hitting a similar smaller tectum anterior to acetabulum III.

The Malaconothridae, as by Balogh (1972), includes the following four genera: *Fossonothrus* Hammer, 1962; *Malaconothrus* Berlese, 1905; *Trimalaconothrus* Berlese, 1917c; *Zeanothrus* Hammer, 1966.

Family TRHYPOCHTHONIIDAE Willmann, 1931

Diagnosis: Neomixosomatae. Cheliceral spatula present. Adoral setae with three pairs present. Mentocoxal fissure present, Λ-shaped. Proteronotum with seta *z*2 club-like or, if setiform, either subequal in length to *j*2 or, if less than 0.5× length *j*2, seta *s* present. Hysteronotal seta *Z*2 nearer *J*2 than *Z*3. Coxite II posterolateral corner sometimes extended as carina with backward facing socket. Opisthosternal setal file *Sa* with two or three setae. On tarsus I, three solenidia usually widely spaced between level of setae *pd*2-*pd*4 (exception: *Hydronothrus*). On tibia I, usually two solenidia (exceptions: *Hydronothrus* and *Mucronothrus* with one solenidium).

Remarks: The eight genera included by Balogh (1972) in the Trhypochthoniidae are decreased in number by subdivision either into the Trhypochthoniellidae or the Allonothridae (Clinofissurae). The following four genera are still included *Archegozetes* Grandjean, 1931; *Hydronothrus* Aoki, 1964; *Mucronothrus* Trägårdh, 1931c; *Trhypochthonius* Berlese, 1905. The conservative emphasis on notal setae results in *Hydronothrus* being grouped in this family, although the leg I setation is similar to that of the Malaconothridae. *Archegozetes* differs considerably from the other three genera, especially with regard to its long leg tarsi and seta *z*2. But some recorded differences, the absence of both a cheliceral spatula and a fissure between coxites II and III (Beck, 1967), are regarded as errors. The presence of a cheliceral spatula and a coxite II/III fissure was recorded by Grandjean (1959) and van der Hammen (1955) and has been confirmed by Dr. R. A. Norton (personal communication, 1983) on specimens from Mexico, Panama (NTm), Brazil (NTb) and Malaysia (Om).

Family TRHYPOCHTHONIELLIDAE Knulle, 1957

Diagnosis: Neomixosomatae. Cheliceral spatula present. Adoral setae with three pairs present. Gnathosternal line (?fissure) present, transverse, linear. Proteronotum with seta *z*2 club-like or setiform and less than 0.5× length *j*2. Hysteronotal seta *Z*2 nearer *J*2 than *Z*3. Coxite II posterolateral corner not extended as carina. Opisthosternal setal file *Sa* with two setae. On tarsus I, three solenidia widely spaced between level of setae *pd*2-*pd*4. On tibia I, one or two solenidia.

Remarks: Trhypochthoniellidae includes two genera: *Trhypochthoniellus* Willmann, 1928; *Afronothrus* Wallwork, 1961. The grouping together of these genera is mainly based on an assumption about gnathosternal structure. They can be regarded as having a quadrate mentum; a "hypostome rechteckig" for *Trhypochthoniellus* (Knulle 1957: 151) or as illustrated for *Afronothrus* (Wallwork 1961: Fig. 7, Hammer 1972: Fig. 19a). The line illustrated on *Afronothrus* could not be the dicoxal fissure which delineates the anterior margin of the "quadrate mentum" of advanced Holosomatina. It is therefore assumed that it is a mentocoxal fissure and there may be a valid quadrate mentum, but careful evaluation of what the drawn line represents is still needed.

Infraorder HOLOSOMATINA

Diagnosis: Comalida. Coxites fused together into a single shield. On genu I, one solenidium. Tibia I solenidia baculiform, piliform or, if flagelliform, closely associated with similar seta. No transverse hysteronotal fissures (exception: ?*TBl* present in some *Crotonia* and *Platynothrus* species). Usually two setae in file *JZa*, always when adanal shields not merged behind anal shields. Cheliceral spatula present.

Remarks: The Holosomatina is regarded as monophyletic, whilst its four subordinate sections (Clinofissurae, Pherenotae, Gymnonotae and Poronotae) are likely to be grades. The lineages have not

been identified, although the Poronotae (being the most derived) could be a clade. Only the most primitive section, the Clinofissurae, is considered in detail below.

A major taxon, the Circumdehiscentiae Grandjean, 1954a (= either the Euoribatida Balogh and Mahunka, 1979 or a major part of the Brachypylina: Balogh, 1972 or the Pherenotae, Gymnonotae plus Poronotae), is regarded as monophyletic but remains unnamed in this classification as before (Lee 1984). This is because it approximates to the Holosomatina (excluding only the six families of the Clinofissurae) and because the fusion of coxites into one shield (which is the synapomorphy of the Holosomatina) is regarded as a predominant step that precludes conditions such as ptychoidy and is a prelude to other states correlated with a thick, rigid idiosomal integument, such as a circular hysterosomal dehiscence line, a dicoxal gnathosternal fissure and a tracheal system opening ventrolaterally between legs II-III or in the acetabular cavities of legs I or III. The presence of a dicoxal gnathosternal fissure may be correlated with the circular hysterosomal dehiscence line of the "Circumdehiscentiae", but a *Nothrus* species is clearly described by Tragårdh (1931a) as having both a dicoxal and a mentocoxal gnathosternal fissure, although this needs confirmation since it is difficult to conceive the function of such a double-jointed system. The presence of a tracheal system appears to be the synapomorphy of a slightly smaller taxon than the "Circumdehiscentiae" since it is absent from the Hermanniellidae.

Section CLINOFISSURAE

Diagnosis: Holosomatina. Gnathosternum usually with Λ -shaped mentocoxal fissure present (exceptions: no fissure in Allonothridae, possibly both mentocoxal and dicoxal fissure present in one *Nothrus* species). If adanal shields separate from hysteronotal shield (i.e. exclude Nanhermanniidae) they do not fuse behind anal shields. Genua subquadrangulate in outline and similar in size to tibiae. Hysterosomal dehiscence line T-shaped, midnotal.

Remarks: The Clinofissurae is diagnosed by character states primitive to the Holosomatina. It is equivalent to the majority of the Nothroidea plus the Nanhermannioidea and Hermannioidea in the previous classification of Balogh (1972), when the latter two superfamilies were included in the higher oribate mites (as "Brachypylina"), although they are excluded from the similar Circumdehiscentiae Grandjean, 1954a. On the other hand, this is the first time that members of the Nothroidea have been included amongst the higher oribate mites (if considered as referring to the Holosomatina).

The following six families are included in this Section: Allonothridae **n.f.**; Camisiidae Oudemans, 1900; Crotoniidae Thorell, 1876; Hermanniidae Sellnick, 1928; Nanhermanniidae Sellnick, 1928; Nothridae Berlese, 1885. All but the Allonothridae and Nothridae are represented in this study and the Allonothridae is considered further as it has to be defined. The Allonothridae, Camisiidae, Crotoniidae and Nothridae can be grouped in the Nothroidea Grandjean, 1954a, but superfamilies will not be considered here.

Family ALLONOTHRIDAE n.f.

Type-genus: *Allonothrus* van der Hammen, 1953

Diagnosis: Clinofissurae. Gnathosternal fissures absent, or, if part of mentocoxal fissure present, lateral parts never meet at mid-point. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic setae *z*2 at least 2x as long as distance *j*2-*z*2, and setiform or slightly swollen distally. Hysteronotal seta *J*4 absent. Hysteronotal gland present. Notal setae *z*1 and *J*5 not on apophyses. Coxite setae not hypertrichous (3-1-3-3). Setal file *Sg* absent, combined setal file *JZg* on median margin of genital shield. Idiosoma not almost covered in continuous shield. No separate preanal shield. Palp tarsus with nine setae. No dorsolateral supernumerary setae on tarsus I. Nymphs without small shields around hysteronotal setal bases.

Remarks: The Allonothridae includes the following two genera: *Allonothrus* van der Hammen, 1953; *Pseudonothrus* Balogh, 1958. The genera are similar to each other and were included in the Trhypochthoniidae (Neomixosomatae, see above), but because of the apparent fusion of all the coxites into one shield they are now grouped in the Holosomatina as a new family. The Allonothridae exhibits similarities to both the Neomixosomatae and Clinofissurae suggesting that they belong to the same lineage, but much more data is needed before a cladistic classification can be proposed within the Comalida.

Family CAMISIIDAE Oudemans

Camisiidae (part) Oudemans, 1900: 142.
Camisiidae (part): Sellnick, 1928: 18.
Camisiidae: Grandjean, 1954a: 431.
Camisiidae (part): Sellnick and Forsslund, 1955: 473.
Camisiidae: van der Hammen, 1959: 65.

Type-genus: *Camisia* von Heyden, 1826

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta *z*2 may be reduced and globular but never enclosed in bothridium, if filamentous length 0.75x-1.5x distance *j*2-*z*2. Hysteronotal seta *J*4 present or absent. Hysteronotal gland present. Notal setae *z*1 and *J*5 sometimes on apophyses. Coxite setae not hypertrichous (3-1-3-3 or 4). Coxite shields usually not merged with

aggenital shields. Setal file *Sg* includes two setae, combined setal file *JZg* on median margin of genital shield. Idiosoma not almost covered in continuous shield. Discrete preanal shield usually as wide as anal shield. Palp tarsus with seven setae. Tarsus I with four or fewer dorsolateral supernumerary setae. Nymphs without small shields around hysteronotal setal bases.

Distribution: Possibly cosmopolitan, greatest diversity in temperate regions, represented in tropical montane or oceanic regions.

Remarks: Camisiidae are small to gigantic (530-1225) dull brown mites, usually covered in cerotegument, thick in parts and with adhering detritus and fungus. Camisiidae has been considered as synonymous with Nothridae, but both names have been in use since Grandjean (1954a) separated them. The family is now still as regarded by Balogh (1972) except that *Austronothrus* is grouped in Crotoniidae (Ramsay and Luxton 1967). Comprehensive descriptions have been made for *Camisia* (Behan 1978; André 1980) and *Platynothrus* (Fujikawa 1982).

The following four genera are included in Camisiidae: *Camisia* von Heyden, 1826; *Heminothrus* Berlese, 1914; *Neonothrus* Forsslund (in Sellick and Forsslund 1955); *Platynothrus* Berlese, 1914. *Heminothrus* and *Neonothrus* are very similar to *Platynothrus*, *Heminothrus* being established earlier (p. 38) in the same reference.

PLATYNOTHRUS Berlese

Platynothrus Berlese, 1914: 99. Type designation (original): "*Nothrus palliatus* K. (=*N. bistriatus* K.)".

Type-species: *Platynothrus peltifer* (Koch, 1839: 29/9).

Diagnosis: Camisiidae. Proteronotal plasmic seta *z2* vermiculate, usually slightly dilated and ciliate distally. One seta in file *s*. Seta *z1* without conspicuous apophysis (at most, shorter than 0.5x distance *z1-z1*). Bothridial cavity with only one side pocket situated near base of seta *z2*. Hysteronotal seta *J4* absent or minute. Seta *J5* without conspicuous apophysis (at most, shorter than its own diameter). Two setae in file *Sg* on inner margin of aggenital shield. Two setae in file *JZa*. Coxites I, II, III merge across midsternal line, coxites IV may be partially or completely separated from each other by fissure. Leg I with six solenidia (1-2-3).

Distribution: Widespread within temperate regions, usually montane or oceanic in tropics. Canada, Greenland (Nn); Argentina, Bolivia, Chile, Peru (NTc); St. Helena (Es); Finland, Norway, Sweden, U.S.S.R., other parts of Europe (Pe); Japan (Ps); Himalayas (Oi); South Australia (Aa); New Zealand (An); South Georgia (ACs).

Remarks: Major works on *Platynothrus* are included in studies on the Swedish fauna (Sellick and Forsslund 1955: 513), Berlese's collection (van der Hammen 1959: 71), Himalayan collections with a key to species (Aoki 1965a: 290) and the northern Japanese fauna (Fujikawa, 1982: 279). Balogh (1972) regards *Platynothrus* as having one pretarsal claw so his keys do not work for species, such as the one described below, which have three pretarsal claws. *Heminothrus* and *Neonothrus* are very similar to *Platynothrus*, and might be grouped in this genus. *Platynothrus* includes seventeen species and two of these have a subspecies.

Platynothrus brevisetosus n.sp.
(Figs 6-12)

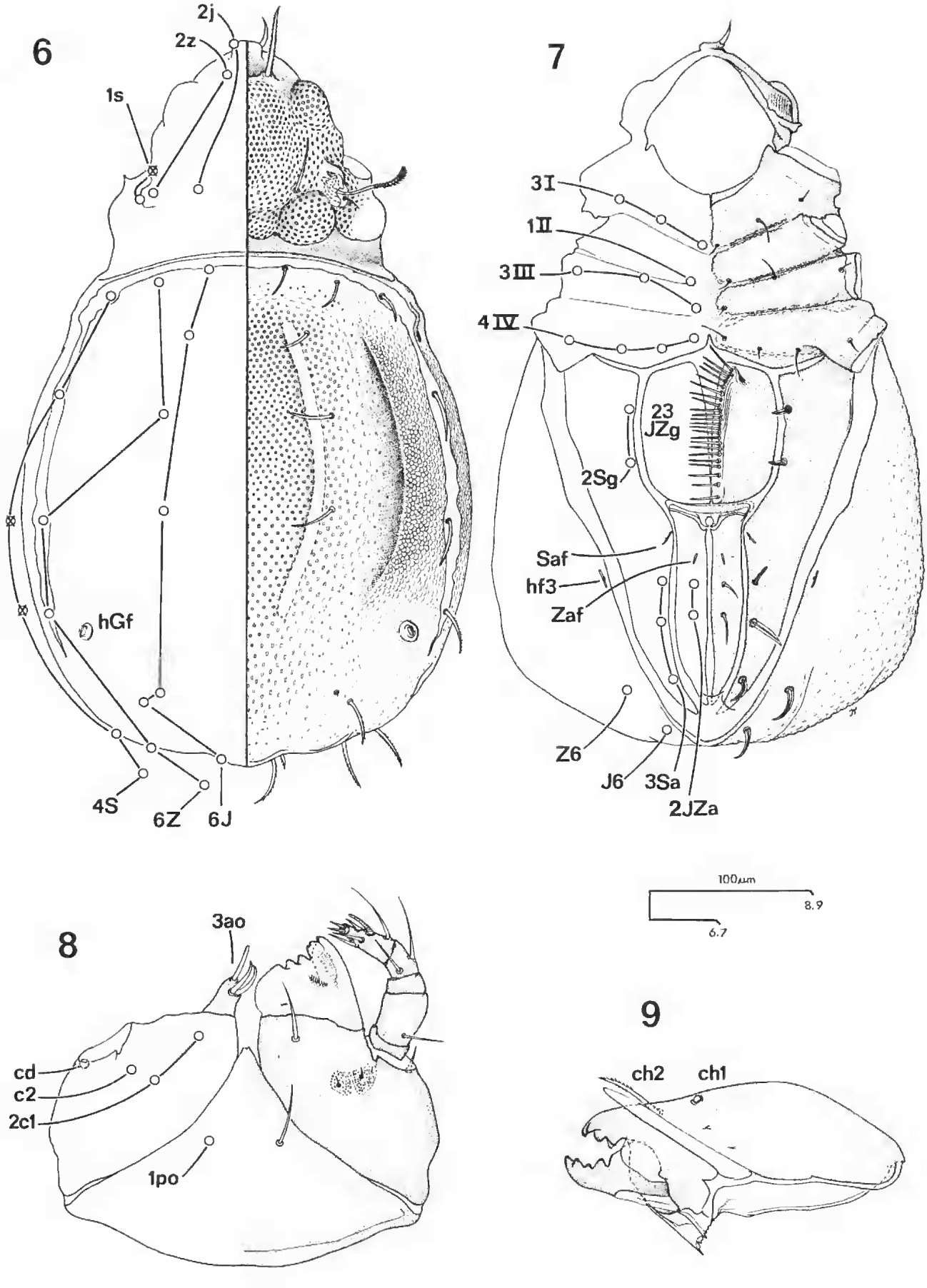
Female

General appearance and measurements: Red-brown, covered in cerotegument, thick with adhering detritus and fungus laterally and posteriorly on hysterosoma and proximally on legs. Notal minute pits and lateral low bumps distributed as illustrated (Fig. 6), whilst all shields covered with fine punctuation except on rostral tectum. Legs similar sculpturing, mainly proximal, ventral and sometimes anterior on individual segments. Setae, claws, external malae, cheliceral digits clear or light brown and refractile. Idiosomal length 1140 (1); appendage lengths—*ch* 65, *pa* 100, *I* 580, *II* 490, *III* 470, *IV* 615; femur breadths—*pa* 25, *I* 75, *II* 75, *III* 65, *IV* 62.5.

Prosternum: Lateral refractile half of external malae in vertical plane when unsquashed (i.e. not flattened as illustrated, Fig. 8) and bears two rows of cilia on dorsal surface. Adoral setae *ao1* blunt-ended. Setae *pc1* and *c2* in shallow, punctated depressions. Coxites all fused into one shield, but clearly delineated by grooves, and separate from aggenital shields.

Proteronotum: Seta *z2* vermiculate, but slightly dilated and ciliate distally. Bothridial cavity with only one side pocket just median to base of seta *z2*, so posterior median wall forms unbroken arc. Surface has central flat-topped mound with two mounds behind it, and mounds above acetabula for legs.

Opisthosternum: Opisthoventral shield separate from coxites, without protrusions from inner margin to bear *Sg* setae. Preanal shield abuts more closely on to anal shield than illustrated (Fig. 7) and appears foreshortened since extends upward in vertical plane. Opisthosternal setae in file *Sa* blade-like, with hyaline flaps on setal core. Genital shield with anteriorly twisted downward median margin bearing setae (Fig. 7) rather than median ridge, also transverse central unpigmented zone. Twenty-three marginal *JZg* setae flattened with slightly ragged, blunt ends. Pores *Zaf* and *Saf* present.



FIGS. 6-9. *Platynothrus brevisetosus* n.sp., female; 6, notum; 7, idiosternum; 8, gnathosternum; 9, right chelicera, anterior surface.

Hysteronotum: Fissure runs transversely along first setal rank and backward along setal files *Z* and *S* (*S1*, *S2*, *Z3*, *Z4*) possibly representing longitudinal pleural fissure. Setae *J2*, *Z2*, *J3* lie between median ridge and lateral furrow. Many hysteronotal setae appear bladelike with hyaline flaps to setal core and marginal cilia, not always illustrated (Fig. 6). Seta *J4* apparently present but minute.

Appendages: Chelicerae relatively small. On fixed digit five teeth including distal point; anterior and posterior teeth in two pairs. Seta *ch1* originally present, but both lost during dissection. Setae: *ch* (2), *pa* (1-0-3-7), *I* (0-10-5-6-28 or 29), *II* (1-10-5-6-23), *III* (4 or 5-6-5-6-23), *IV* (0-5-4-6-23). Solenidia: *pa* (0-0-1), *I* (1-2-3), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Pretarsus with three subequal claws, lateral claws with inconspicuous dorsal cilia file. Terminal plasmic setae on palp tarsus spine-like, in recess. Solenidia baculiform, relatively short never 2x length of associated seta, longest on genu I. Tarsi all with supernumerary setae. Setae colourless, on tarsi have strongly refractile bases but hyaline tips.

Somal inclusions: No eggs or boli. Ovipositor involuted, if extended would be about 3x length of genital shield. Breadth slightly less than that of one genital shield. Bears eight pairs of setae, two *dg* pairs longer than setae *JZg*, three *pg* pairs more than length of genital shield away from three *mg* pairs.

Male

Unknown.

Material examined: Holotype female (N198328), litter under *Pinus pinea*, Knott Hill Forest, 22.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Knott Hill, cultivated pine forest, 1 (1/2).

Remarks: P. brevisetosus, with three pretarsal claws, short hysteronotal setae and well-spaced setae *J2*, keys to *P. altimontanus* Hammer, 1958 from Bolivia in Aoki's (1965a) work as would *P. tenuiclava* Hammer, 1966 from New Zealand which is possibly even more similar. *P. brevisetosus* is distinguishable from these two species by the presence of a rudimentary *J4*, hysteronotal fissures, large size, blade-like hysterosomal setae and stout setae *j1* and *z1*.

Family CROTONIIDAE Thorell

Crotonoides Thorell, 1876: 452-508.
Holonothridae Wallwork, 1963: 727.
Crotoniidae: Ramsay and Luxton, 1967: 479.

Type-genus: *Crotonia* Thorell, 1876.

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta *z2* reduced, globular and enclosed within bothridium. Hysteronotal seta *J4* present. Hysteronotal gland absent. Notal setae *z1* and *J5* usually on conspicuous apophyses. Coxite *I* or *II* setae sometimes hypertrichous but not *III* and *IV* (3 or 4 - 1 or 2-3-2 or 3). Coxite shields merged with aggenital shields. Setal file *Sg* includes two or three setae, combined setal file *JZg* on median margin of genital shield. Idiosoma not almost covered in continuous shield. Discrete preanal shield as wide as anal shield. Palp tarsus with nine setae. Tarsus *I* with five pairs of dorsolateral supernumerary setae. Nymphs with small shields around hysteronotal setal bases.

Distribution: Southern temperate regions as for *Crotonia*. *Austronothrus* from New Zealand, *Holonothrus* from New Zealand and Macquarie Island (An, Sa).

Found in plant litter, and on lichen, liverworts, moss, ferns and above-ground parts of shrubby plants.

Remarks: Crotoniidae are large to gigantic (801-1500), dull, dark brown mites, extensively covered in cerotegument and detritus which may be accompanied by nymphal skins and fungi. The unique structure of the bothridium enclosing a globular *z2* is regarded as the family synapomorphy.

The following three genera are included in Crotoniidae: *Austronothrus* Hammer, 1966; *Holonothrus* Wallwork, 1963; *Crotonia* Thorell, 1876.

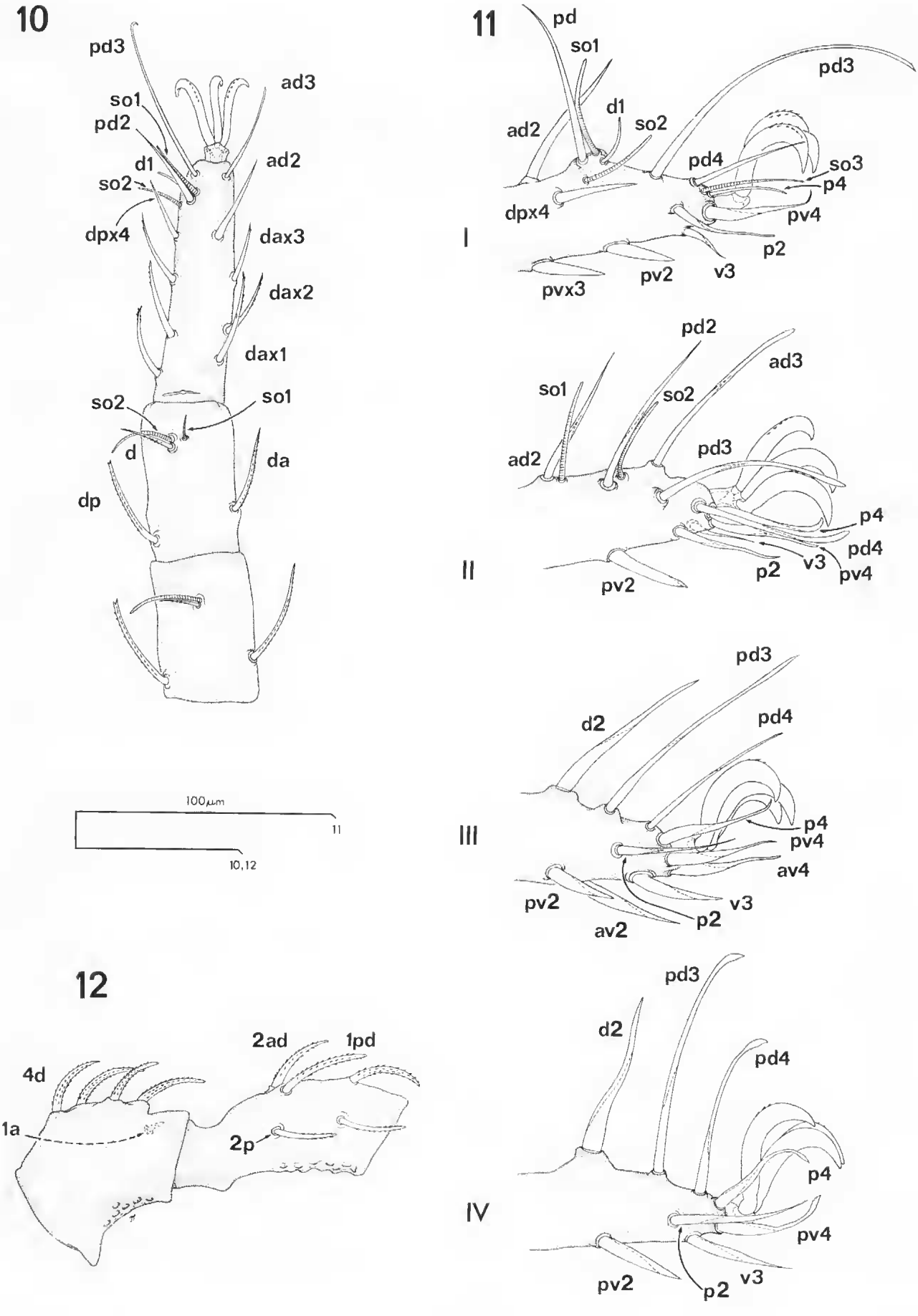
CROTONIA Thorell

Westwoodia Pickard-Cambridge, 1875: 383-390. Type designation (original): "*Westwoodia obtecta* sp.nov."
Crotonia Thorell, 1876: 452-508. Type designation (original): "*Crotonia obtecta* (Pickard-Cambridge, 1875)".
Acronothrus Berlese, 1917a: 65. Type designation (original): "*Nothrus (Acronothrus) cophinarius* Mich. 1908".

Type-species: *Crotonia obtecta* (O. Pickard-Cambridge, 1875: 386).

Diagnosis: Crotoniidae. Hysteronotal setation reduced to thirteen pairs (*J2*, *J3*, *Z1* missing). Bases of setae *J1* and *Z2* without connecting ridge. Rostral tectum with single prominence bearing both setae *j1*. Setae *z1* on separate conspicuous apophyses. Setae *J5* (and other posterior setae) on separate apophyses or on single median branched apophysis. Posterior margin of coxites *IV* in smooth arc not broken by median notch. Opisthosternal file *JZa* includes three setae.

Distribution: Widespread in southern temperate regions (NTc; Ee, Es; Aa, Ap, An; Sa)—see Hammer and Wallwork (1979) for a review. Note that South



FIGS. 10-12. *Platynothrus brevisetosus* n.sp., female; 10, leg I, dorsal surface of genu, tibia and tarsus; 11, leg tarsi, posterior surface of distal ends; 12, leg III, posterior surface of trochanter and femur.

Ethiopian record is St. Helena. More recent records from Tierra del Fuego (Mahunka 1980b) and New Zealand (Luxton 1982).

Usually found in moist forest or heath in the plant litter, moss or on the above-ground parts of shrubby plants (Luxton 1982).

Remarks: The thick layer of cerotegument, detritus and nymphal skins obscures the dorsal features of *Crotonia* mites as illustrated by photograph of *C. obtecta* (O. Pickard-Cambridge) (Ramsay and Luxton 1967: Fig. 8). *Crotonia* may currently include twenty-four species, and Luxton (1982) provides a key for fifteen adequately described species.

Crotonia jethurmerae n.sp.
(Figs 13-19)

Female

General appearance: Dark brown, thick cerotegument with adhering detritus (including charcoal, left by forest fires), fungal hyphae and tritonymphal integument. Encrustation forms anterior protrusion encompassing setae *z*1 and posterior protrusion encompassing setae *J*4, *J*5, *Z*5, *S*5 (small on some specimens, then bilobed). Notal minute pits and low bumps distributed as illustrated (Fig. 13). Setae, claws, external malae, cheliceral digits clear or light brown and refractile. Idiosomal length 1400 (3, 1390-1405). Proportions of appendages similar to those for male holotype (see below).

Prosternum: Lateral refractile half of external malae in vertical plane when unsquashed (i.e. not flattened as illustrated, Fig. 15) and bears two rows of cilia on dorsal surface. Three adoral setae, *ao*1 bifurcate, flattened, one branch forming denticulate hyaline flap. Coxites all fused into one shield, partly delineated by grooves but leaving broad, flat mid-sternal zone, fused to aggenital shields. Hyaline cap on coxite seta may be broken off, leaving slim setal core. Coxite setae *III*3 and *IV*1 on apophyses.

Proteronotum: Seta *z*2 globular, enclosed in bothridial cavity with faint reticulate markings on lining, and appears as if slit-like opening to exterior between pair of ear-like folds. Cuticular pits confined to concavities at sides of high, flat median zone, which falls steeply to rostral prominence. No setae observed in file *s*, but if small would be difficult to distinguish amongst adhering detritus. Apophysis to seta *z*1 medium length (about equal to distance *z*1-*z*1) with curved lateral flap.

Opisthosternum: Aggenital shield fused to coxites and only narrowly joined to adanal shield, with raised median rim near preanal shield and small notch anterior to seta *Sg*2 (one female has 3*Sg* on one side). Preanal shield well separated from other shields, foreshortened as illustrated (Fig. 14) since extends upward in vertical plane. Number of opisthosternal setae blade-like, with hyaline flap on setal core. Genital shield has central transverse unpigmented zone embracing setae *JZg*5, *JZg*6 and notch between them (structure suggests shield may fold along this line). No pore *Zaf* located on anal shield although *Saf* and *hf*3 conspicuous.

Hysteronotum: Fissure runs transversely along beside first setal rank and backward along setal files *Z* and *S* (*S*1, *S*2, *Z*3, *Z*4) possibly representing dorsolateral longitudinal fissure. Ventrolateral longitudinal fissure terminates anteriorly, dorsal to posterior margin of acetabulum *IV*, so that anterior part of opisthosomal pleural shield merges with podosomal shield. Comparison with Camisiidae, adult and nymphs, suggests seta "*d*1" is *Z*2 not *J*2, so hysteronotal chaetotaxy 4*J*, 5*Z*, 4*S*, but concept of centralward migration of *Z*2 and lost *J*2 debatable.

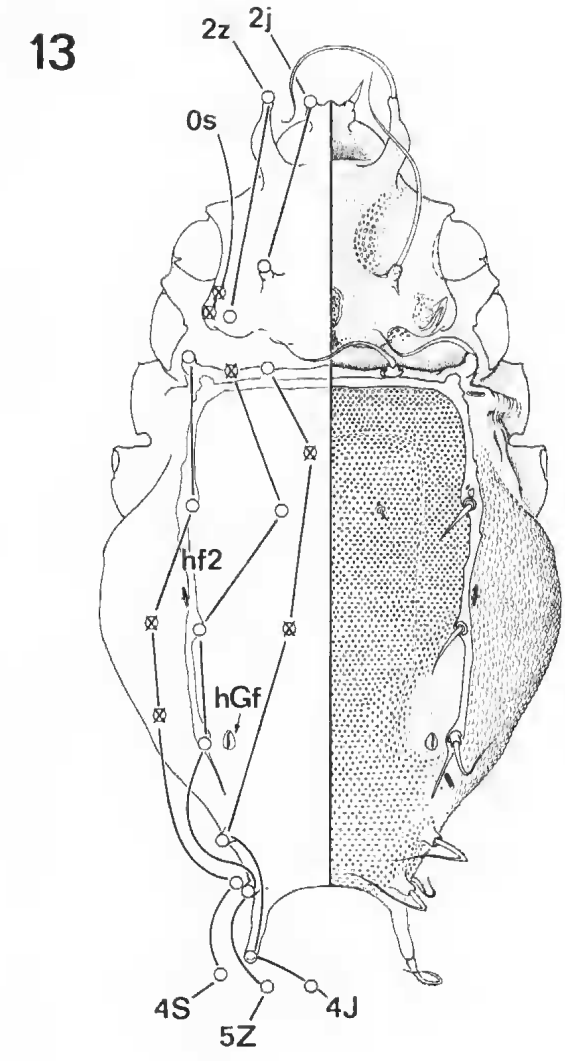
Appendages: Chelicerae relatively small, both digits terminating in paired, nearly parallel teeth (including distal points), with single large tooth proximally. Setae: *ch* (2), *pa* (1-1-3-9), *I* (0-12-5-6-38), *II* (0-12-5-6-30 to 32), *III* (5-7-5-5-28 or 29), *IV* (1-8-5-5-29 to 31). Solenidia: *pa* (0-0-1), *I* (1-1-2), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Pretarsus with three subequal claws, lateral claws with dorsal cilia file. Four terminal plasmic setae on palp with minute distal knob. Solenidia piliform, never more than 1.25x length of associated setae. Solenidia on genua and tibiae *II, III, IV* similar to one on genu I (Fig. 17), but similar-sized or smaller than associated setae. Tarsi all with supernumerary setae. Setae pale brown, or colourless on tarsi with strongly refractile base but hyaline distally.

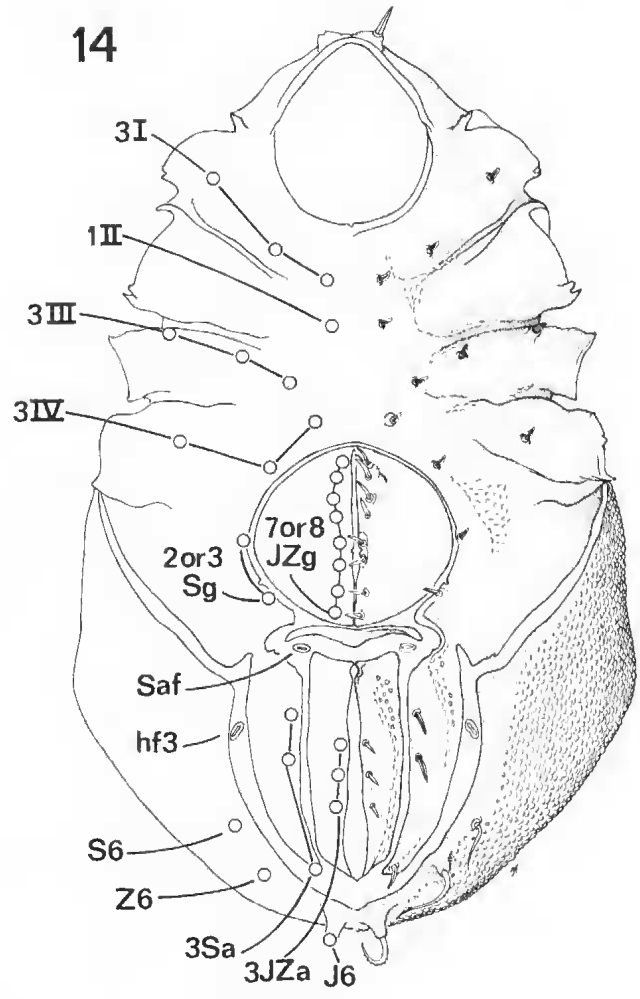
Somal inclusions: Three paratype females each with four or five eggs. Eggs smooth, suboval, 305-310 long, 170-175 broad. Ovipositors involuted, extended would be about 2x length of genital shield. Breadth slightly less than that of one genital shield. Difficult to make out setae, setae *dg* longer than *JZg*. Two clearly delineated boli present per specimen, mainly cellular material, spores, hyphae, cellular sheets of plant tissue.

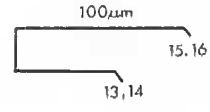
Male

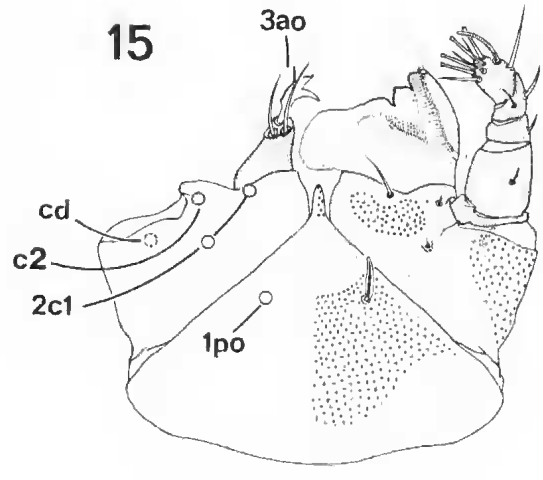
Measurements and spermapositor (otherwise as female): Idiosomal length 1185 (8, 1125-1290); appendage lengths (for 1185, holotype)—*ch* 77.5, *pa* 110, *I* 1220, *II* 747.5, *III* 762.5, *IV* 905; femur breadths—*pa* 22.5, *I* 110, *II* 100, *III* 92.5, *IV* 87.5. Opisthosoma contains large, granular horseshoe-shaped organ (open end at posterior), possibly gonad. Spermapositor short, breadth about half that of one genital shield, setae *dg* about half length of *JZg*.

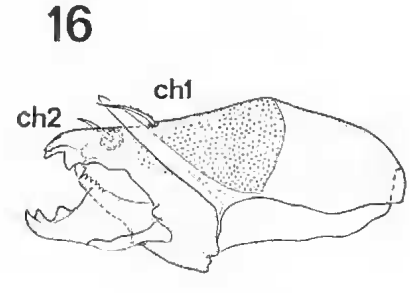
Material examined: Holotype male (N198317), seven paratype males (N198318-N198324), three paratype females (N198325-N198327), litter and sparse moss,



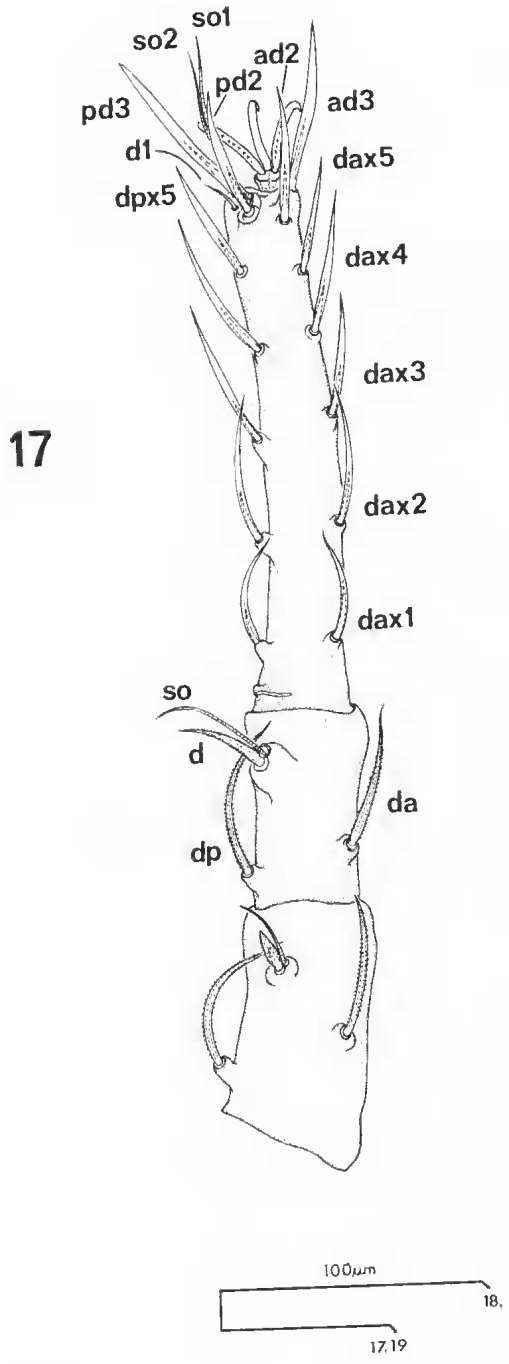


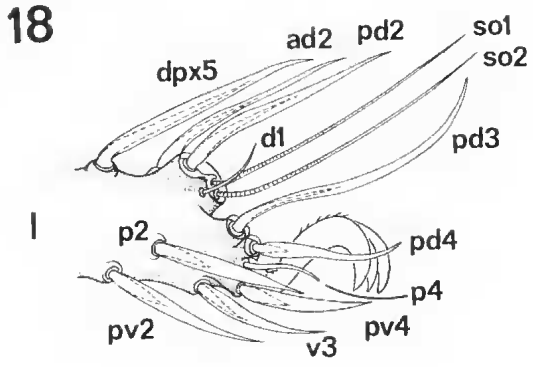


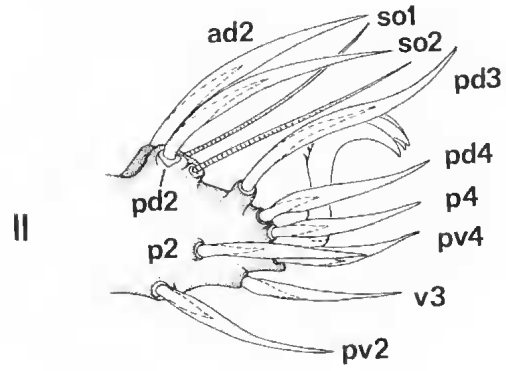


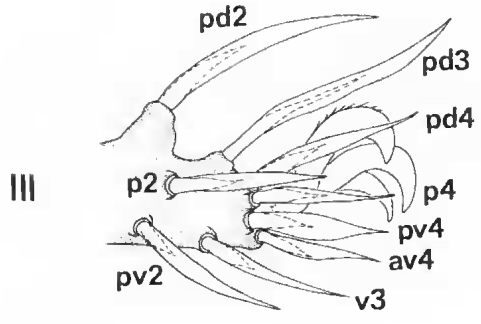


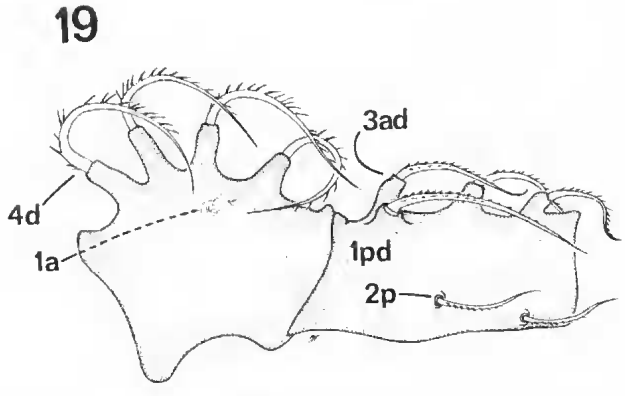
FIGS. 13-16. *Crotonia jethurmerae* n.sp., male except when otherwise indicated; 13, notum; 14, female idiosternum; 15, gnathosternum; 16, right chelicera, anterior surface.

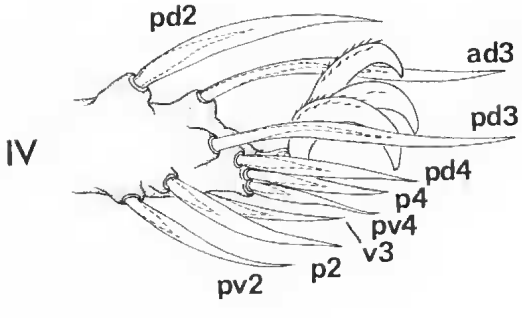












FIGS. 17-19. *Crotonia jethurmerae* n.sp., male; 17, leg I, dorsal surface of genu, tibia and tarsus; 18, leg tarsi, posterior surface of distal ends; 19, leg III, posterior surface of trochanter and femur.

under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll open-forest, 11 (5/8).

Remarks: Because one male has little pigment or cerotegument and therefore is easy to examine, it is designated holotype in contrast to the usual procedure of so designating a female.

Luxton (1982) divides *Crotonia* into five species-complexes, amongst which *C. jethurmerae* would be grouped in the *cophinaria*-complex. The inclusion of *C. jethurmerae* requires modification of the characteristics of that complex in that hysteronotal setae *J1* and *S1* are approximately equal in length, also setae *j1* is thorn-like and straight. The curved lateral flap on the apophysis to seta *z1* appears unique within the genus.

Family NANHERMANNIIDAE Sellnick

Nanhermanniidae Sellnick 1928: 17.
Nanhermanniidae: Woolley and Higgins, 1956: 913.

Type-genus: *Nanhermannia* Berlese, 1914: 100.

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta *z2* baculiform or dilated and ciliate distally, length 1x-3x distance *j2-z2*. Hysteronotal seta *J4* present. Hysteronotal gland absent. Notal setae *z1* and *J5* not on apophyses. Coxites *II*, *III* and *IV* may be hypertrichous. Setal file *Sg* includes two setae, combined setal file *JZg* on median margin of genital shield. Idiosoma almost covered in continuous shield except for relatively well separated genital and anal orifices, and prehysteronotal fissure extending ventrally (? anterior part of ventrolateral longitudinal fissure) as crescentric split nearly meeting midway between genital and anal orifices. Discrete preanal shield but internal under anterior margin of anal shields. Palp trochanter fused to femur, tarsus with seven setae. Tarsus *I* with one or two pairs of dorsolateral supernumerary setae (solenidium *so1* level with them). Nymphs without small shields around hysteronotal setal bases.

Distribution: Probably cosmopolitan. Beside *Nanhermannia*, *Masthermannia* may be cosmopolitan. *Cyrthermannia* is tropical (Cuba, NTa; Thailand, Os) as well as occurring in Japan (Pc). Whilst *Cosmohermannia* is known from southern Japan (Pc) and New Guinea (Am).

Found in woodland and forest litter (both fermentation and humus layers).

Remarks: The only thoroughly described species in Nanhermanniidae is *Masthermannia* (as *Posthermannia*) *nematophora* (Grandjean, 1954b). The family was revised by Woolley and Higgins (1956). Although two genera and a number of species have been described since then, the form of Nanhermanniidae is without great variations from that of the original species.

Nanhermanniidae includes the following four genera: *Cosmohermannia* Aoki and Yoshida, 1970; *Cyrthermannia* Balogh, 1958; *Masthermannia* Berlese, 1914; *Nanhermannia* Berlese, 1914.

NANHERMANNIA Berlese

Nanhermannia Berlese, 1914: 100. Type designation (original): "*Hermannia nana* Nic".

Type-species: *Nanhermannia nana* (Nicolet, 1855: 458).

Diagnosis: Nanhermanniidae. Hysteronotal setae not on swollen tubercles, simple, either setose or lanceolate, sometimes minute forwardly directed proximal spur. Posterior margin of hysteronotum evenly convex without prominent protuberances. Coxites *III*, *IV* with two to four and three or four setae respectively. Trochanter *IV* with three dorsal setae.

Distribution: Probably cosmopolitan. Canada (Nn); Washington (Nc); Colorado, Idaho (Nr); Maryland, North Carolina (Na); Chile, Patagonia, Peru (NTc); Angola, Rhodesia (Ee); St. Helena (Es); Europe—most northern records Iceland and Kola Peninsula (Pe); Italy (Pm); Altay Mountains, Kunashir Island, Sakhalin Island, Samarkand (Ps); Japan (Pc); Thailand (Os); Philippines (Om); New Guinea (Am); Queensland, South Australia (Aa); New Zealand (An).

Remarks: Nanhermannia is the most widely recorded genus in the family and currently includes at least nineteen species. Balogh and Mahunka (1978), in describing *N. domrowi* from Queensland, refer to a *thaiensis*-complex based on *N. thaiensis* Aoki, 1965b characterized by "medially confluent posterior protuberances of the prodorsum and that they do not have longitudinal furrows among interlamellar setae". For convenience, I will redefine the *thaeinsis*-complex which includes the species from this study.

thaiensis-complex

Diagnosis: Nanhermannia. Pair of posterior proteronotal protuberances basically semicircular, each with four to seven minor protuberances. Furrow between setal pair *j2* absent or shallow, not breaking connection between protuberances. Genua and tibiae *I* and *II* seta not bifurcate.

Remarks: Unfortunately the diagnosis has to be based on the posterior sculpturing of the proteronotum, which

is difficult to use for some intermediate species. The *thaiensis*-complex is regarded as including the following six species: *N. domrowi* Balogh and Mahunka, 1978—Queensland (Aa); *N. forsslundi* Karppinen, 1958—Finland (Pe); *N. gorodkovi* Sitnikova, 1975—Altay Mountains and Kunashir Island (Ps); *N. grandjeani* **n.sp.**—South Australia (Aa); *N. pectinata* Strenzke, 1953—Germany (Pe); *N. thaiensis* Aoki, 1965b—Thailand (Os).

Nanhermannia grandjeani n.sp.
(Figs 20-26)

Female

General appearance and measurements: Light brown generally, darker around leg acetabula and posterior proteronotal protuberances. Shallow, clear cerotegument, some adhering detritus around leg bases. Setae, claws, external malae, cheliceral digits clear and refractile. Coarse puncta over much of soma excluding lateral regions of proteronotum, coxites, genital and anal shields, and crescent shape on both sides of setal file *Sa* (see Fig. 21). Much smaller but deeper puncta located dorsally on proteronotum and central part of each coxite. Idiosomal length 637.5 (1); appendage lengths—*ch* 42.5, *pa* 55, *I* 265, *II* 250, *III* 220, *IV* 280; femur breadths—*pa* 12.5, *I* 52.5, *II* 55, *III* 40, *IV* 40.

Prosternum: External malae without adaxial hyaline flap, but midanterior flap ventral to discrete tubercle, two rows of long cilia on dorsal surface. Three adoral setae, *ao*1 very fine. Coxites merged with each other and surrounding shields, although delineated by grooves.

Proteronotum: Seta *z*2 club-like, ciliate on dilated area. Seta *j*2 has inconspicuous posterior spur at base. Middorsal T-shaped flat-topped mound with setae *z*1 at anterior end and setae *z*2 at end of lateral arms. Region often used in species diagnosis illustrated in detail (Fig. 24). Furrow between setae *j*2 shallow, accentuated by absence of small puncta that cover T-shaped mound. Posterior proteronotal protuberances obscure matching but smaller ventral protuberances (Fig. 20).

Opisthosternum: Shields distributed in manner unique to *Nanhermannia*. File *JZg* with nine setae and *Sa* with three setae. Pores *Zaf* and *Saf* present, other two pores illustrated (Fig. 22) regarded as hysteronotal (*hf*).

Hysteronotum: Some setae (at least *J*2, *Z*2, *Z*3, *S*1, *S*2, *S*5) with inconspicuous anterior spur at base. All setae blade-like, with hyaline dorsal and ventral flaps along entire length, not long enough in first three ranks to reach base of following seta.

Appendages: Chelicerae relatively small. On fixed digit five teeth including distal point, two small adaxial teeth parallel to main two proximal teeth. Movable digit with three teeth, including paired distal points and large proximal tooth. Setae: *ch* (2), *pa* (1-0-2-7), *I* (1-5-5-6-23), *II* (1-7-5-5-22), *III* (5-2-2-3-18), *IV* (1-3-2-2-16). Solenidia: *pa* (0-0-1), *I* (1-1-2), *II* (1-1-2), *III* (1-1-0), *IV* (1-1-0). Pretarsus with one claw. Terminal pair of plasmic setae on palp tarsus spine-like, in recess. Anterodorsal edge of tarsal tibia with refractile spur. Solenidia baculiform, relatively short, never as long as associated setae. Tarsi *I* and *II* each with two supernumerary setae; possibly both *dp*. On tibiae *III* and *IV* (only illustrated on *IV*—Fig. 25) seta *av* conspicuously longer than segment.

Somal inclusions: No eggs. Ovipositor involuted, extended would be about 2x length of genital shield. Breadth slightly less than that of one genital shield. Bears eight pairs of setae, two *dg* pairs about 0.6x length of setae *JZg* and 4x length of setae *pg*. One small bolus, granular, particles many shapes, no complete cell walls present.

Male

Unknown.

Material examined: Holotype female (N198329), litter and sparse moss, under *Eucalyptus obliqua*, Mt. Lofty, 9.5.1974, D. C. Lee.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll open-forest, 1 (1/8).

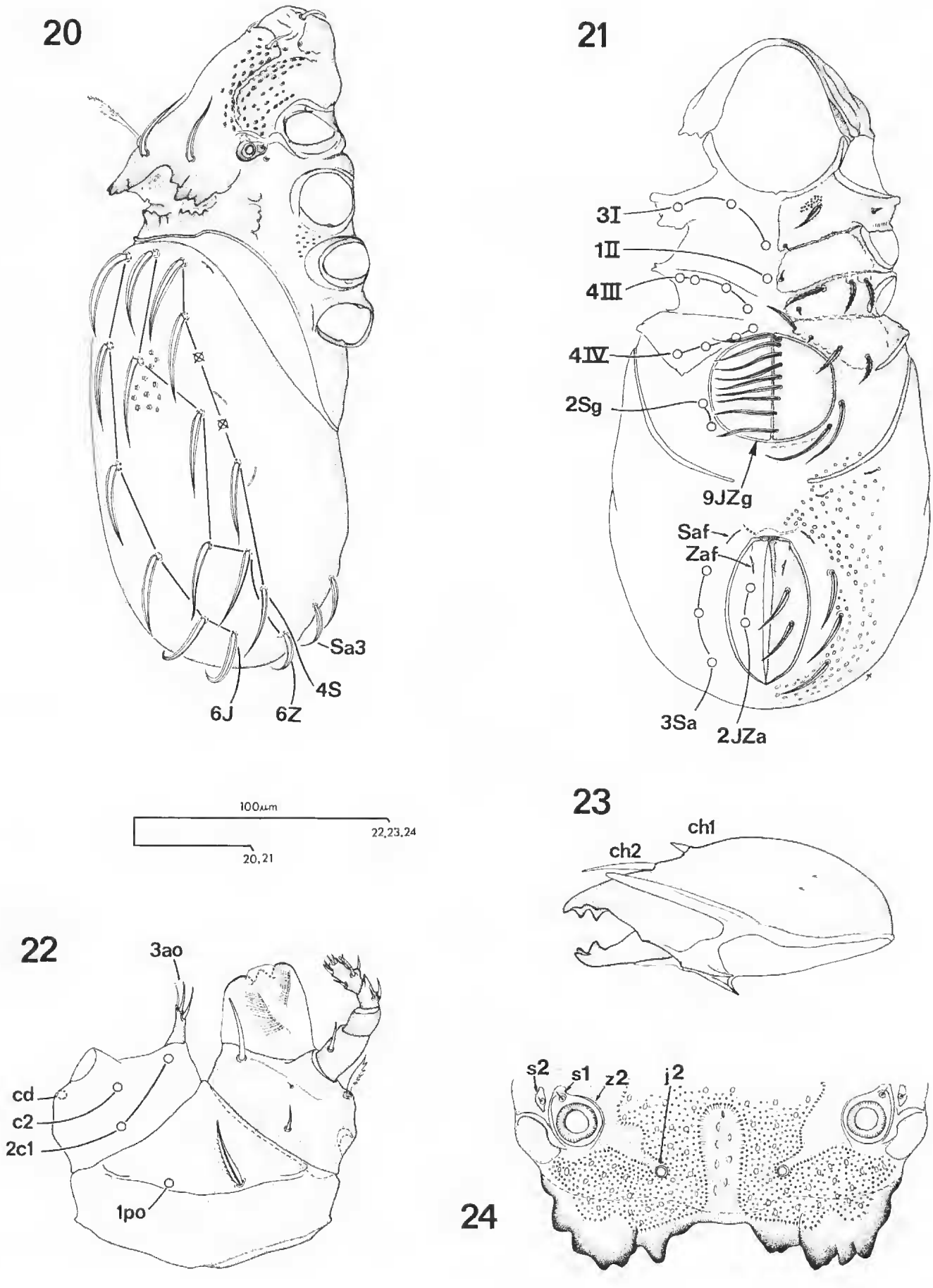
Remarks: Amongst the *thaiensis*-complex, differences between species in the description of proteronotal protuberances and the intermediate furrow may be actual or represent different interpretations by authors. Within such variations *N. grandjeani* lies between *N. pectinata* and *N. domrowi*. The shortness of the hysteronotal setae distinguishes *N. grandjeani* from *N. domrowi*, *N. forsslundi* or *N. gorodkovi*. *N. pectinata* has no large puncta on the proteronotal T-shaped mound and seta *z*2 is not dilated distally. *N. thaiensis* has shorter, laterally biased protuberances, hysteronotal puncta are larger and uneven in size and shape whilst opisthosternal file *Sa* includes only two setae and the coxites bear only nine setae ventrally (3-1-2-3).

Family HERMANNIIDAE Sellnick

Hermanniidae Sellnick, 1928: 18.
Hermanniidae: Woas, 1981: 7.

Type-genus: *Hermannia* Nicolet, 1855.

Diagnosis: Clinofissurae. Gnathosternal Λ-shaped mentocoxal fissure present, at least median part. Three pairs of adoral setae. Rostral tectum without median incision. Proteronotal plasmic seta (*z*2) filamentous or club-like, length 0.75x-1.5x distance *j*2-*z*2. Hysteronotal seta *J*4 present. Hysteronotal gland present. Notal setae *z*1 and *J*5 not on apophyses. Coxites *III* and *IV* setae



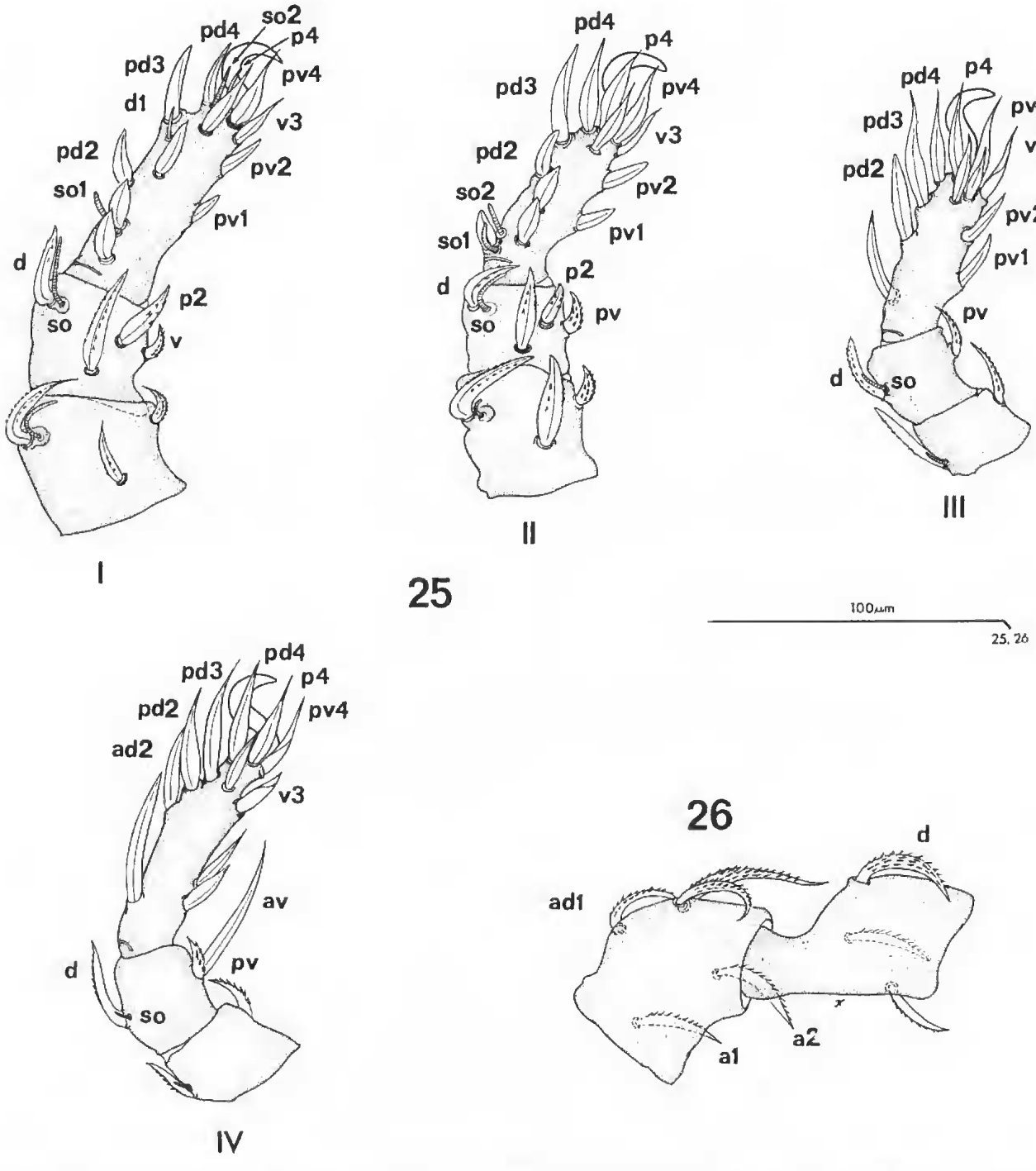
FIGS. 20-24. *Nanhermannia grandjeani* n.sp., female; 20, notum and right pleura; 21, idiosternum; 22, gnathosternum; 23, right chelicera, anterior surface; 24, proteronotum, posterior protuberances.

hypertrichous (3-1-4 or 5-5 or 7). Setal file *Sg* includes two to five setae, setal files *Jg, Zg* separate but may be close together. Idiosternum almost covered in continuous shield but well separated from notal shield. Discrete preanal shield, narrow (width about distance *JZa1-JZa2*). Palp tarsus with nine setae. Tarsus *I* without dorsolateral supernumerary setae. Nymphs without small shields around hysteronotal setal bases.

Distribution: Possibly cosmopolitan. *Phyllhermannia* found mainly in southern hemisphere (see below) whilst *Hermannia* confined to Palaearctic and Nearctic regions.

Species of *Hermannia* occur on bark of living trees, regularly in forest litter, often at high altitudes, also in littoral habitats and salt marsh (Krantz, 1978).

Remarks: A recent study of the Hermanniidae by Waos (1981) makes *Phyllhermannia* a junior synonym of *Hermannia,* so that all species are in a single genus, with both types in the *gibbia/convexa*-complex. His study is disadvantaged by the brief descriptions of southern hemisphere species, i.e. those previously grouped in *Phyllhermannia.* The below description is the first comprehensive study of a *Phyllhermannia* species,



FIGS. 25-26. *Nanhermannia grandjeani* n.sp., female; 25, legs, dorsal and posterior surfaces of genua, tibiae and tarsi; 26, leg III posterior surface of trochanter and femur.

and character states such as the reduced setation of the palp coxite, palp femur and legs, as well as the shape of adoral seta *ao*2, suggest that *Phyllhermannia* may still be a valid taxon. Therefore, I have chosen what may appear a weak character (the position and shape of seta *z*1) to diagnose the two genera, because it has always been described and it makes a conservative grouping, requiring only one species to be excluded from *Phyllhermannia*. This is a temporary measure until *Phyllhermannia phyllophora* is properly described.

The following two genera are included in Hermanniidae: *Hermannia* Nicolet, 1855; *Phyllhermannia* Berlese 1917a.

PHYLLHERMANNIA Berlese

Phyllhermannia Berlese, 1917a: 65. Type designation (original): "*Hermannia phyllophora* Mich."
Phyllhermannia: Trägårdh, 1931b: 576.
Hermannia (in part): Woas, 1981: 36.

Type-species: *Phyllhermannia phyllophora* (Michael, 1908: 140).

Diagnosis: Hermanniidae. Proteronotal seta *z*1 with distal half tapered off to a point, and marginal, lateral to line *j*1-*j*2. Opisthoventral shield with transverse strip between genital and anal shields. Mentocoxal fissure usually complete, reaching edge of gnathosternum (exception: *Phyllhermannia tuberculata*).

Distribution: Widespread in southern hemisphere, known range extending into northern hemisphere along western border of Pacific ocean. Chile, Juan Fernandez Islands (NTc); Cape Province, Natal (Es); Madagascar, Mauritius (Em); Tanganyika (Ee); southern Japan (Pc); Thailand, Vietnam (Os); Java, Philippines (Om); South Australia (Aa); New Zealand (An); Puntas Arenas (Sm).

Remarks: Phyllhermannia was established without any diagnosis, probably on the basis of the leaf-like leg setae. The first detailed consideration of the genus was by Trägårdh (1931b) and keys to some species are given by Aoki (1965b) and Balogh and Mahunka (1966). Woas (1981) regards this genus as a synonym of *Hermannia* and includes most species in his *gibba/convexa*-complex.

The diagnosis of the genus used here is weak since the character states of the opisthoventral shield and mentocoxal fissure also occur in the small (after the exclusion of *Phyllhermannia* species) *gibba/convexa*-complex within *Hermannia*. My approach has been to maintain *Phyllhermannia* until more extensive descriptions of included species, especially the type, are available. Only one species has to be excluded from this genus: *Hermannia aerolata* (Aoki, 1970) from Japan. This is still grouped in the *gibbia/convexa*-complex as by Woas (1981: 36).

Twenty-four species and one subspecies are included in *Phyllhermannia*. One species (*P. africana* Balogh, 1958) has not been considered because of the insufficient description. Of the remainder, ten species are considered similar to the new species described below and these are grouped in a species-complex.

eusetosa-complex

Diagnosis: Phyllhermannia. Hysteronotal seta *Z*1 central, not migrated laterally in front of *S*1, distance *Z*1-*J*2 subequal to or less than *J*1-*J*2. Hysteronotal setae short, *J*1 not reaching *J*2 base. Apodemes between coxites *I-II* and *II-III* oblique, at least at 22.5° angle to transverse axis. Genital setal file *Zg* with at least one seta twice length of *Sg* setae, or more. Leg setae never leaf-like or spatulate and number reduced, tarsus I with 23 or fewer setae and one solenidium.

Remarks: Members of the *eusetosa*-complex are usually only known by idiosomal character states. The three species from Mauritius, with only one setae in opisthosternal file *Sg*, may form a separate complex. *P. tuberculata* from Chile is included although unique within the genus in having a restricted mentocoxal fissure as in many *Hermannia* species.

Eleven species are included in the complex. *P. bimaculata* Hammer, 1979—Java (Om); *P. eusetosa* **n.sp.**—South Australia (Aa); *P. foliata* Hammer, 1966—New Zealand (An); *P. mauritii* Mahunka, 1978—Mauritius (Em); *P. modesta* Mahunka, 1978—Mauritius (Em); *P. mollis* Hammer, 1966—New Zealand (An); *P. pacifica* Hammer, 1972—Tahiti (Ap); *P. pauliani* Balogh, 1962—Madagascar (Em); *P. rubra* Hammer, 1966—New Zealand (An); *P. tremicta* Mahunka, 1978—Mauritius (Em); *P. tuberculata* Covarrubias, 1967—Chile (NTc).

Phyllhermannia eusetosa n.sp.
(Figs 27-32)

Female

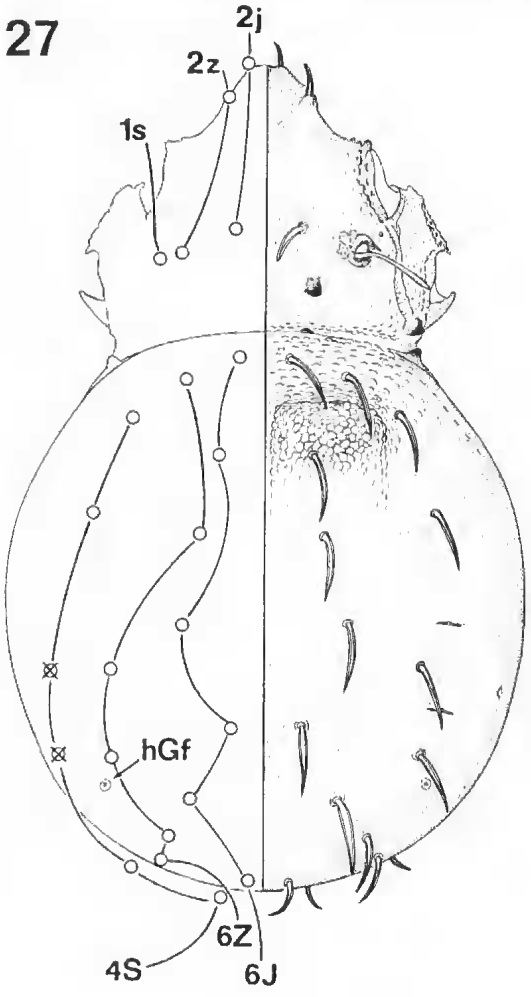
General appearance and measurements: Red-brown, covered in cerotegument, thin with sparse adhering detritus. Beside small tubercles laterally and around coxites, acetabula and genital and anal orifices, soma (excepting proteronotum) covered in low, minute, superficial bumps, with pale strips between forming a reticulate pattern. All shields covered with fine puncta. Similar puncta and pattern on legs. Idiosomal length 795 (25, 675-917.5); appendage lengths (for holotype, 915)— *ch* 57.5, *pa* 90, *I* 580, *II* 430, *III* 440, *IV* 585; femur breadths— *pa* 27.5, *I* 117.5, *II* 105, *III* 90, *IV* 95.

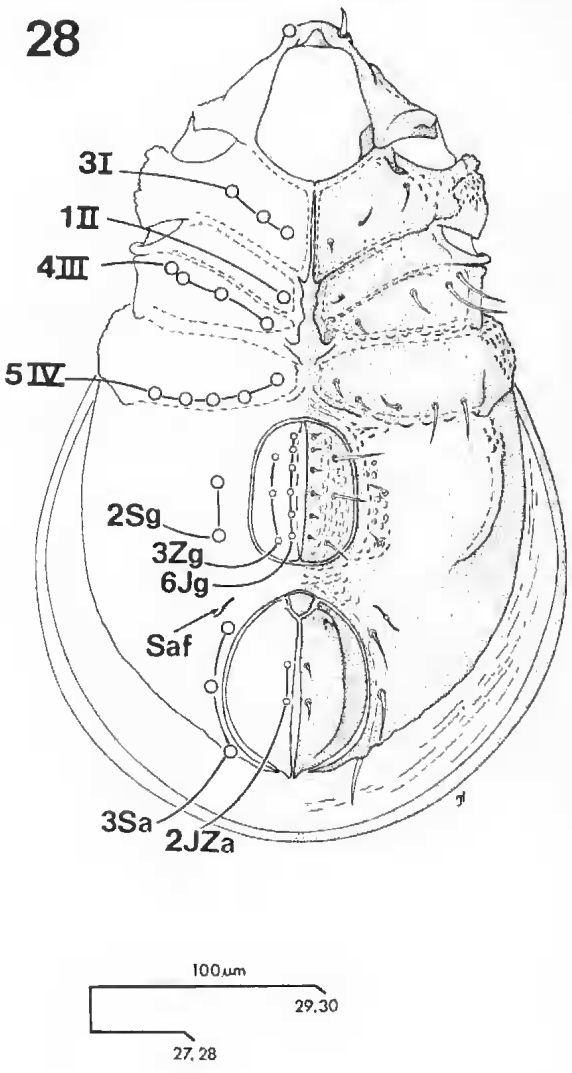
Prosternum: On external malae median hyaline flap horizontal with posterior notch through which adoral seta *ao*3 protrudes. Internal mala with distal spike leading back to minute dorsal furrow. Lateral refractile

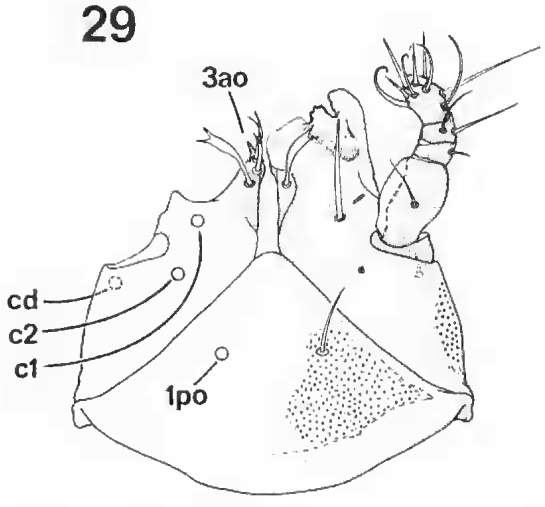
part of external malae bears two rows of cilia on dorsal surface. Lateral and central gnathosternum with finely punctate patches as illustrated (Fig. 29). Coxites all fused into one shield but clearly delineated by grooves, deep along midsternal line.

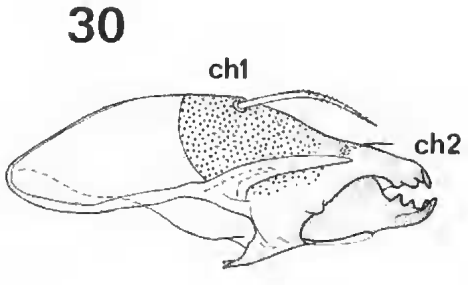
Proteronotum: Seta *z*2 vermiculate, but slightly dilated and ciliate distally. Bothridial cavity for seta *z*2 with number of short pockets and one long pocket. Two pairs of sharp tubercles near posterior margin face backwards, dark and conspicuous although small: one lies at posterior end of ridge running backwards from acetabulum *I*, other lies posterior to setae *j*2 and *z*2 and equidistant from both.

Opisthosternum: Continuous opisthoventral shield with strip between genital and anal shields, broadly fused to coxites, but not fused together posterior to anal

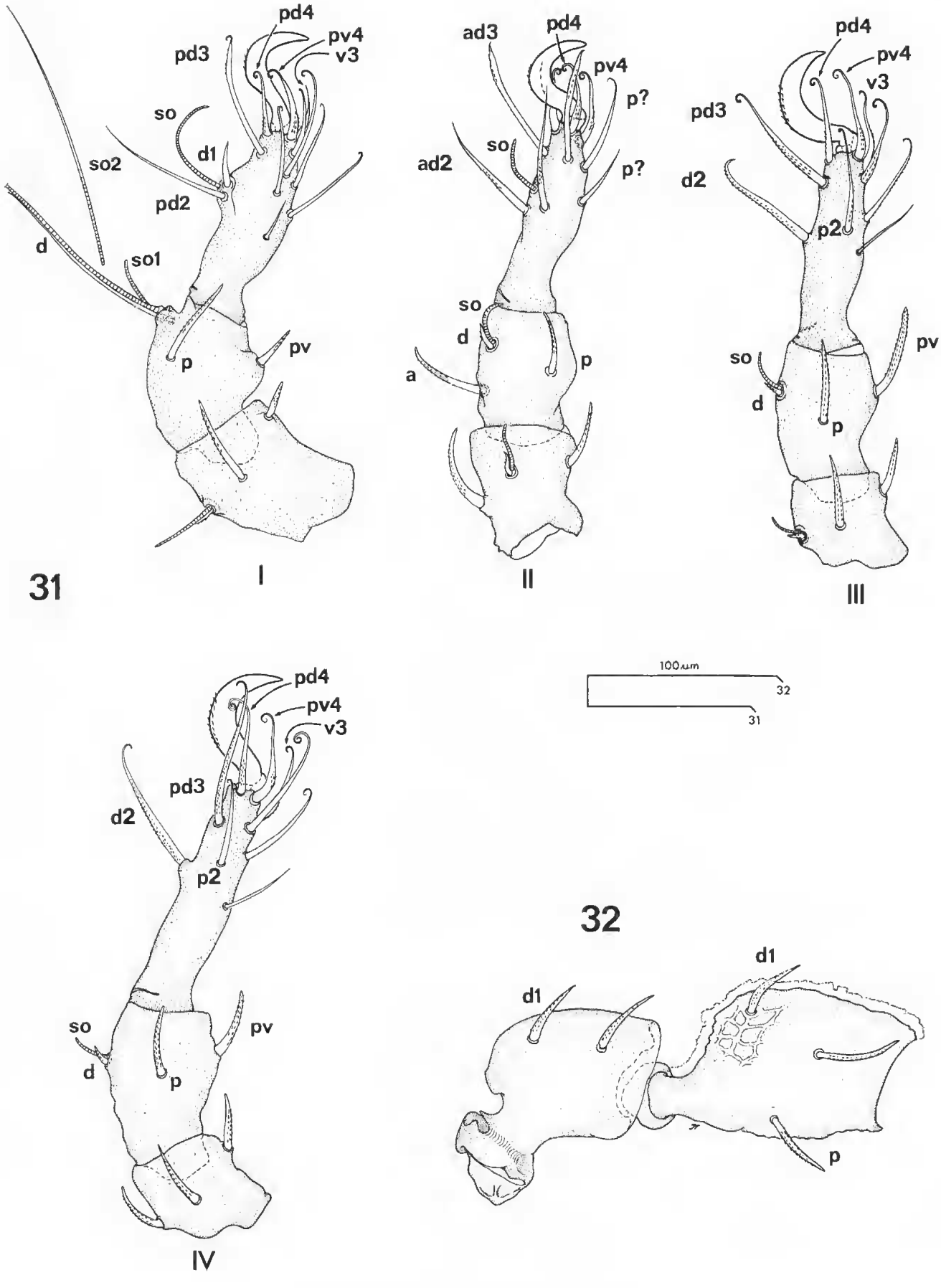








FIGS. 27-30. *Phyllhermannia eusetosa* n.sp., female; 27, notum; 28, idiosternum; 29, gnathosternum; 30, left chelicera, anterior surface.



FIGS. 31-32. *Phyllhermannia eusetosa* n.sp., female; 31, legs, dorsal and posterior surfaces of genua, tibiae and tarsi; 32, leg III posterior surface of trochanter and femur.

shields. Groove behind coxite *IV*. Cresent-shaped thickening of integument behind acetabulum *IV*. Anal shield with longitudinal ridge ending anteriorly in tubercle that fits around preanal shield. Both this tubercle and crescent-shaped thickening behind acetabulum *IV* conspicuously dark-coloured, although with pale shading (Fig. 28) because they stand proud from surrounding shields. Pore *Saf* present but not *Zaf*.

Hysteronotum: Two pairs of tubercles near anterior margin, ventral to circumhysteronotal fissure and opposing proteronotal tubercles, central pair small and inconspicuous. Pair of dark semicircular integument thickenings behind first rank of hysteronotal setae (*J*1, *Z*1, *S*1), from which central arm borders on inconspicuous furrow running back to bend as faint ridge around seta *J*4. All hysteronotal setae blade-like.

Appendages: Chelicerae relatively small. Both digits with four teeth, terminating in paired, nearly parallel teeth (including distal points). Palp femur with anteroventral flange. Setae: *ch* (2), *pa* (0-1-1-3-9), *I* (0-6-5-5-22), *II* (1-7-5-5-17), *III* (2-3-2-4-15), *IV* (2-4-3-4-14). Solenidia: *pa* (0-0-1), *I* (1-2-1), *II* (1-1-1), *III* (1-1-0), *IV* (0-1-0). Pretarsus with single claw bearing pair of inconspicuous dorsal cilia files. Terminal pair of plasmic setae on palp tarsus spine-like, with anterodorsal flange around their bases. All but one solendium baculiform, relatively short, less than 0.5x length of segment bearing them. Solendium *so*2 on tibia I flagelliform, very long, about equal to length of genu, tibia and tarsus I together. On genua *I, II, III*, and on all tibia (excluding *sol* on tibia I) solenidia coupled with dorsal setae, whilst solenidia on tarsi *I, II* and *sol* on tibia *I* at most only associated with dorsal setae. Reticulate pattern on dorsal and lateral surfaces of most leg segments (Fig. 32—part drawn on femur), but not on dorsal surface of trochanter or any part of tarsi. This pattern consists of darker raised ridges unlike similar hysteronotal pattern.

Somal inclusions: Amongst twenty-five registered specimens, three contain two eggs, one contains three eggs, five contain four eggs, remainder without eggs. Eggs about 240 (225-265) long, ellipsoid, with uniform smooth surface. Ovipositor 2x length of genital shield. Breadth about 1.5x that of one genital shield. Bears eight pairs of setae, two *dg* pairs subequal in length to setae *Zg*2 but thorn-like (x2 breadth) and more refractile, three *pg* pairs about length of genital shield away from three *mg* pairs. Only one bolus seen with mainly unrecognisable fragments, but some spherical spores and one multicellular strip of tissue.

Male

Unknown.

Material examined: Holotype female (N198330), and twenty-four paratype females (N1983417-N1983440), under *Eucalyptus obliqua*, sclerophyll forest, Mt. Lofty, 9.5.1974.

Distribution: South Australia—Aa: Mt. Lofty, sclerophyll forest, 118 (6/8).

Remarks: P. eusetosa is distinguishable from other members of the *eusetosa*-complex in possessing the following combination of character states: hysteronotal setae blade-like without cilia, no proteronotal ridge runs either between setae *j*2-*j*2 or seta *j*2 and the median tubercle near posterior margin; coxite *IV* bears five setae.

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REFERENCES

ANDRÉ, H.M. 1980. Description of *Canisia carrolli* n.sp., with a comparison to two other arboreal *Canisia* (Acari, Oribatida). *Internat. J. Acarol.* **6**: 141-146.

AOKI, J. 1961. Beschreibungen von neuen Oribatiden Japans. *Japanese Jour. Appl. Ent. Zool.* **5**: 64-69.

AOKI, J. 1964. A new aquatic oribatid mite from Kauai Island. *Pacif. Insects* **6**: 483-488.

AOKI, J. 1965a. Oribatid mites (Acarina: Oribatei) from Himalaya with descriptions of several new species. *J. Coll. Arts Sci. Chiba Univ.* **4**: 289-302.

AOKI, J. 1965b. Oribatiden (Acarina) Thailands. I. *Nat. Life SEast Asia* **4**: 129-193.

AOKI, J. 1965c. Notes on the species of the genus *Epilohmannia* from the Hawaiian Islands (Acarina: Orbatei). *Pacif. Insects* **7**: 309-315.

AOKI, J. 1970. A peculiar new species of the genus *Phyllhermannia* collected at Mt. Fuji (Acari: Hermanniidae). *Bull. natn. Sci. Mus., Tokyo* **13**: 71-75.

AOKI, J. and YOSHIDA, K. 1970. A new oribatid mite, *Cosmohermannia frondosus*, gen.n. et sp.n. from Yakushima Island. *Bull. biogeogr. Soc. Japan* **26**: 1-4.

BALOGH, J. 1958. Oribatides nouvelles de l'Afrique tropicale. *Rev. Zool. Bot. afr.* **58**: 1-34.

BALOGH, J. 1960. Oribates (Acari) nouveaux de Madagascar (1 ere sér.) *Mem. Inst. Sci. Madagascar* **14**: 7-37.

BALOGH, J. 1961. An outline of the family Lohmanniidae Berl. 1916 (Acari: Oribatei). *Acta. zool. hung.* **7**: 19-44.

BALOGH, J. 1962. Recherches sur la faune endogee de Madagascar. VII Oribates (Acariens). *Naturaliste Malgache* **13**: 121-151.

BALOGH, J. 1968. New oribates (Acari) from New Guinea. *Acta zoo. hung.* **14**: 259-285.

BALOGH, J. 1972. *The oribatid genera of the world.* Akadémiae Kiado, Budapest, 188 pp, 71 pls.

BALOGH, J. and MAHUNKA, S. 1966. New oribatids (Acari) from South Africa. *Acta zool. hung.* **12**: 1-23.

BALOGH, J. and MAHUNKA, S. 1969. The scientific results of the Hungarian Soil Zoology Expeditions to South America. 10. Acari: Oribatids, collected by the second expedition. I. *Acta zool. hung.* **15**: 1-21.

BALOGH, J. and MAHUNKA, S. 1978. Data to the oribatid fauna of Australia (Acari). I. *Opusc. zool. Bpest* **15**: 31-49.

BALOGH, J. and MAHUNKA, S. 1979. New taxa in the system of the Oribatida (Acari) *Ann. Hist. -nat. Mus. Nat. Hung.* **71**: 279-290.

BALOGH, J. and MAHUNKA, S. 1981. New data to the knowledge of the oribatid fauna of the Neogaea. VI (Acari) *Acta. zool. hung.* **27**: 49-102.

BAYOUMI, B. M. and MAHUNKA, S. 1976. Contributions to the knowledge of the genus *Epilohmannia* Berlese, 1916 (Acari: Oribatida) *Folia ent. hung.* **29**: 5-21.

BECK, L. 1967. Beiträge zur Kenntnis der neotropischen Oribatidenfauna, 5. *Archegozetes.* (Arach., Acari) *Senck. biol.* **48**: 407-414.

BEHAN, V. M. 1978. *Camisia labradorica* (Acari: Oribatei: Camisiidae): a new soil mite species from the Canadian Subarctic. *Can. Ent.* **110**: 547-550.

BERLESE, A. 1885. *Note relative agli Acari, Miriapodi e Scorpioni italiani. Fascicolo III.* Padova, 31 pp.

BERLESE, A. 1905. Acari nuovi. Manipulus III. *Redia* **2**: 10-32.

BERLESE, A. 1910. Acari nuovi. Manipulus VI. *Redia* **6**: 215-234.

BERLESE, A. 1914. Acari nuovi. Manipoli VII-VIII. *Redia* **9**: 77-111.

BERLESE, A. 1917a. Centuria prima di Acari nuovi. *Redia* **XII**: 19-67.

BERLESE, A. 1917b. Centuria seconda di Acari nuovi. *Redia* **12**: 125-177.

BERLESE, A. 1917c. Centuria terza di Acari nuovi. *Redia* **12**: 289-338.

BHATTACHARYA, T. and BANERJEE, R. 1980. Some cryptostigmatid mites (Acari: Oribatei) from Birbhum District, West Bengal, India *Indian J. Acar.* **4**: 19-24.

CORPUS-RAROS, L. A. 1979. Philippine Oribatei (Acarina) II. Family Lohmanniidae *Kalikasan* **8**: 315-334.

COVARRUBIAS, R. 1967. New oribatids from Chile. *Opusc. Zool. Budapest* 7(2): 89-116.

CSISZAR, J. 1961. New oribatids from Indonesian soils (Acari) *Acta. zool. hung.* **7**: 345-366.

ELBADRY, E. A. and NASR, A. K. 1977. Two new species of the genus *Papillacarus* from Egypt. *Dtsch. Ent. Z., N.F.* **24**: 367-369.

FUJIKAWA, T. 1982. The six species of the genus *Platynothrus* from Hokkaido. *Acarologia* **23**: 279-294.

GRANDJEAN, F. 1931. Observations sur les Oribates (1 re serie) *Bull. Mus. nat. Hist. natur.* (2), **3**: 131-144.

GRANDJEAN, F. 1950. Étude sur les Lohmanniidae (Oribates, Acariens) *Archs Zool. exp. gen.* **87**: 95-162.

GRANDJEAN, F. 1954a. Essai de classification des Oribates (Acariens). *Bull. Soc. zool. France* **78**: 421-446.

GRANDJEAN, F. 1954b. *Posthermannia nematophora* n.g., n.sp. (Acarien, Oribate) *Rev. franc. Ent.* **21**: 298-311.

GRANDJEAN, F. 1957. L' infracapitulum et la manduction chez les oribates et d'autres acariens. *Ann. Sci. natur. Zool.* (11), **19**: 233-281.

GRANDJEAN, F. 1958. *Perlohmannia dissimilis* (Hewitt) (Acarien, Oribate) *Mém. Mus. nat. Hist. natur. (n.s.), ser. A. Zool.* **16**: 57-119.

GRANDJEAN, F. 1959. Observations sur les Oribates (40e série) *Bull. Mus. nat. Hist. natur.* (2), **31**: 359-366.

GRANDJEAN, F. 1969. Considerations sur le classment des oribates leur division en 6 groupes majeurs. *Acarologia* **11**: 127-153.

HAFEEZ KARDAR, M. A. 1972. A new species of Lohmanniidae (Acarina: Oribatei) from India. *Oriental Insects* **6**: 61-63.

HAMMEN, L. VAN DER. 1953. Notes on the Oribatei (Acari) of Dutch New Guinea. I. *Allonothrus schulingi* nov.gen., nov.spec. *Proc. Kon. Ned. Ak. Wet., ser. C.* **56**: 244-250.

HAMMEN, L. VAN DER. 1955. Notes on the Oribatei (Acari) of Dutch New Guinea. II. A redescription of *Archegozetes magna* (Sellnick) *Proc. Kon. Ned. Ak. Wet., ser. C.* **58**: 90-97.

HAMMEN, L. VAN DER. 1959. Berlese's primitive oribatid mites. *Zool. Verh., Leiden* **40**: 1-93.

HAMMER, M. 1958. Investigations on the oribatid fauna of the Andes Mountains. I. The Argentine and Bolivia. *Biol. Skr.* **10**: 1-129, 34 pls.

HAMMER, M. 1962. Investigations on the oribatid fauna of the Andes Mountains. III. Chile. *Biol. Skr.* **13**: 1-96, 30 pls.

HAMMER, M. 1966. Investigations on the oribatid fauna of New Zealand. Part I. *Biol. Skr.* **15**: 1-108, 45 pls.

HAMMER, M. 1966. Investigation on the oribatid fauna of Tahiti, and on some oribatids found on the atoll Rangiroa. *Biol. Skr.* **19**: 1-65, 26 pls.

HAMMER, M. 1979. Investigations on the oribatid fauna of Java. *Biol. Skr.* **22**: 1-78, 47 pls.

HAMMER, M. and WALTWORK, J. A. 1979. A review of the world distribution of oribatid mites (Acari: Cryptostigmata) in relation to continental drift. *Biol. Skr.* **22**: 2-31.

HEYDEN, C. H. G. VON. 1826. Versuch einer systematischen Eintheilung der Acariden *Isis, Oken* **18**: 611-613.

JACOT, A. P. 1930. Oribatid mites of the subfamily Phthiracarinae of the Northeastern United States. *Proc. Boston. Soc. nat. Hist.* **39**: 209-261, 10 pls.

KAESTNER, A. 1970. *Invertebrate Zoology, volume 3, class Crustacea, translated by Levi, H. W. and Levi, L. R.* John Wiley & Sons, New York, 523 pp.

KARPPINEN, E. 1958. Mitteilungen uber einige fur Finnland neue Oribariden (Acar.). *Suom. hyonl. Aikak.* **24(4)**: 192-196.

KNULLE, W. 1957. Morphologische und Entwicklungsgeschicht liche Untersuchungen zum phylogenetischen System der Acari: Acariformes Zachv. I. Oribatei: Malaconthridae. *Mitt. Zool. Mus. Berl.* **33**: 97-213.

KOCH, C. L. 1839. *Deutschlands Crustaceen, Myriapoden und Arachiden* Regensburg (not seen).

KRANTZ, G. W. 1978. *A manual of Acarology.* Oregon State University, 509 pp.

KUNST, M. 1959. Bulgarische Oribatiden (Acarina) III. *Acta Univ. Carol. (Biol.)* **1**: 51-74.

LEBRUN, Ph. and WAUTHY, G. 1981. Quelques observations et reflexions sur les peuplements d'Oribates hypoges (Acariens). *Annls Soc. r. zool. Belg.* **111**: 131-142.

LEE, D. C. 1981. Sarcoptiformes (Acari) of South Australian soils. I. Notation 2. Bifemorata and Ptyctima (Cryptostigmata). *Rec. S. Aust. Mus.* **18**: 199-222.

LEE, D. C. 1982. Sarcoptiformes (Acari) of South Australian soils. 3. Arthronotina (Cryptostigmata). *Rec. S. Aust. Mus.* **18**: 321-359.

LEE, D. C. 1984. A preliminary revised classification for oribatę mites (Acari: Cryptostigmata). In: Griffiths, D. A. (ed.) *Proceedings of the 6th International Congress of Acarology*: 241-248.

LUXTON, M. 1982. Species of the genus *Crotonia* (Acari: Cryptostigmata) from New Zealand. *J. Linn. Soc. (Zool.)* **76**: 243-271.

McDANIEL, B. and BOLEN, E. G. 1983. A new species of *Epilohmannia* from Texas and new distribution records for *Epilohmannia pallida* Wallwork (Oribatida: Epilohmanniidae). *Internat. J. Acarol.* **9**: 37-41.

MAHUNKA, S. 1973. Zwei neue Lohmanniiden-Arten aus Korea (Acari: Oribatida). *Folia ent. hung.* **26**: 49-56.

MAHUNKA, S. 1974. Neue und interessante Milben aus dem Genfer Museum. XII. Beitrag zur Kenntnis der Oribatiden-Fauna Griechenlands (Acari) *Rev. suisse Zool.* **81**: 569-590.

MAHUNKA, S. 1978. Neue und interessante Milben aus dem Genfer Museum, XXVII. A first survey of the Oribatid (Acari) fauna of Mauritius, Reunion and the Seychelles I. *Rev. suisse Zool.* **85**: 177-236.

MAHUNKA, S. 1980a. Oribatids from Tunisian soils (Acari: Oribatida). I. *Folia ent. hung.* **33**: 123-134.

MAHUNKA, S. 1980b. Neue und interessante Milben aus dem Genfer Museum. XXXVIII. Oribatids (Acari) from Monte Susana (Tierra del Fuego, Argentina). *Rev. suisse Zool.* **87**: 155-181.

MICHAEL, A. D. 1898. *Oribatidae*, in Das Tierreiche, volume 3, 93 pp.

MICHAEL, A. D. 1908. Unrecorded Acari from New Zealand. *J. Linn. Soc. (Zool.)* **30**: 134-149.

NICOLET, H. 1855. Histoire naturelle des Acariens qui se trouvent aux environs de Paris. *Arch. Mus. Hist. Nat.* **7**: 381-482.

NORTON, R. A. and METZ, L. J. 1980. Nehypochthoniidae (Acari: Oribatei), a new mite family from the Southeastern United States. *Ann. Entomol. Soc. Am.* **73**: 54-62.

NORTON, R. A., METZ, L. J. and SHARMA, G. D. 1978. Observations on *Epilohmannoides* Jacot, 1936 (Acarina, Oribatei), with the description of a new species. *J. Georgia Entomol. Soc.* **13**: 129-134.

NORTON, R. A., O'CONNOR, B. M. and JOHNSTON, D. E. 1983. Systematic relationships of the Pediculochelidae (Acari: Acariformes). *Proc. Entomol. Soc. Wash.* **85**: 493-512.

O'CONNOR, B. M. 1984. Phylogenetic relationships among higher taxa in the Acariformes, with particular reference to the Astigmata. In: Griffiths, D. A. (ed). *Proceedings of the 6th International Congress of Acarology*: 19-27.

OUDEMANS, A. C. 1900. Remarks on the denomination of the genera and higher groups in "Das Tierreich, Oribatidae". *Tijdschr. Ent.* **43**: 140-149.

OUDEMANS, A. C. 1917. Notizen uber Acari, 25. Reihe (Trombidiidae, Oribaridae, Phthiracaridae). *Arch. Naturg.* **82**, A6: 1-84.

OUDEMANS, A. C. 1923. Studie over de sederi 1877 ontworpen systemem der Acari; nieuwe classificatie; phylogenetische beschouwingen. *Tijdsche. Ent.* **66**: 49-85.

PEREZ-INIGO, C. 1967. Les Lohmanniidae d'Espagne (Acari: Oribatei). *Eos* **43**: 157-170.

PERTY, M. 1841. *Allgemein Naturgeschichte, als Philosopische und Humanitat-swissenschaft fur Nocturforscher, Philosophen und das hoher gebildete Publikum, 3,* Bern (not seen).

PICKARD-CAMBRIDGE, O. 1875. On three new and curious forms of Arachnida. *Ann. Mag. nat. Hist. (4)* **16**: (95): 383-390.

RAMSAY, G. W. and LUXTON, M. 1967. A redescription of the type specimen of *Crotonia (=Acronothrus) obtecta* (Pickard-Cambridge 1875), and a discussion of its taxonomic relationships. *J. nat. Hist.* **4**: 473-480.

SCHUSTER, R. 1960. Uber die Morphologie und Artengliederung der Gattung *Epilohmannia* Berlese 1917; (Ac., Oribatei). *Zool. Anz.* **165**: 197-213.

SELLNICK, M. 1928. Formenkreis: Hornmilben, Oribatei. *Tierw. Mitteleur.* **3 (9)**: 1-42.

SELLNICK, M. and FORSSLUND, K. H. 1955. Die Camisiidae Schwedens (Acar. Oribat.). *Ark. Zool. (2)* **8**: 473-530.

SITNIKOVA, L. G. 1975. (Superfamilies Nothroidea, Nanhermannoidea, Hermannielloidea, Liodoidea). 71-115, illustr. *In*: Gilyarov, M. S. (ed.) *(Identification key of soil inhabiting mites. Sarcoptiformes),* Nauka, Moscow, 491 pp.

STRENZKE, VON K. 1953. Zwei neue Arten der Oribatiden—Gattung *Nanhermannia. Zool. Anz.* **150**: 69-75.

THORELL, T. 1876. Sopra alcuni Opilioni (Phalangidea) d'Europa e dell' Asia occidentale, con un quadro dei generi europei di quest' Ordine. *Ann. Mus. Civ. Stor. Nat. Genov.* **8**: 452-508.

TRAGARDH, I. 1931a. Concerning the mouthparts of the oribatids. *Entomol. Tidskr.* **3-4**: 209-217.

TRAGARDH, I. 1931b. Acarina from the Juan Fernandez Islands. *In*: The Natural History of Juan Fernandez and Easter Island, volume III. (Ed.) C. Skottsberg. *Nat. Hist. Juan Fernandez & Easter Is.* **3**: 553-628.

TRAGARDH, I. 1931c. Terrestrial Acarina. *Zoology Faroes* **49**: 1-69.

WALLWORK, J. A. 1961. Some oribatei from Ghana. V. Two members of the family Trhypochthoniidae, including a description of a new genus. *Acarologia* **3**: 232-241.

WALLWORK, J. A. 1962a. Some oribatei from Ghana. X. The family Lohmanniidae. *Acarologia* **4**: 457-487.

WALLWORK, J. A. 1962b. Some oribatei from Ghana. XI. The genus *Epilohmannia* Berlese 1916. *Acarologia* **4**: 671-693.

WALLWORK, J. A. 1963. The oribatei (Acari) of Macquarie Island. *Pacif. Ins.* **5**: 721-769.

WILEY, E. O. 1981. *Phylogenetics, the theory and practice of Phylogenetic Systematics.* New York, John Wiley and Sons, 439 pp.

WILLMANN, C. 1928. Neue Oribatiden. I. *Zool. Anz.* **76**: 1-5.

WOAS, S. 1981. Zur Taxonomie und Phylogenie der Hermanniidae Sellnick 1928 (Acari, Oribatei). *Andrias* **1**: 7-88.

WOOLLEY, T. A. 1969. The infracapitulum—a possible index of oribatid relationship. *Int. Congr. Acarology* **2. Budapest:** 209-221.

WOOLLEY, T. A. and HIGGINS, H. 1956. A revision of the family Nanhermanniidae (Acari: Oribatei). Proc. Tenth Int. Congress of Ent. **1**: 913-923.